GOVERNMENT OF INDIA

सत्यमेव जयते

MINING & MARKETING OF INDIAN MANGANESE ORE

(Report of the Committee on Manganese Ore)

AUGUST, 1965

PRINTED IN INDIA BY THE MANAGER GOVT OF INDIA PRESS NASIK AND PUBLISHED BY THE MANAGER OF PUBLICATIONS DELHI-6
1966

With the compliments of

R. N. Vasudeva

Chairman

COMMITTEE ON MANGANESE ORE

&

Joint Secretary

MINISTRY OF MINES & METALS

सत्यमेव जयते

R. N. VASUDEVA,
Joint Secretary &
Chairman, Committee
on Manganese Ore

DEPARTMENT OF MINES AND METALS
(MINISTRY OF STEEL & MINES)
NEW DELHI
4th September, 1965

Dear Minister,

The late Ministry of Commerce & Industry constituted a Committee on manganese ore under the Government of India Resolution No. 20 (3)/63-BOT, dated 29th June, 1963, to study the problems of mining and marketing of Indian manganese ore.

Subsequently this Committee was reconstituted and in October 1964 I was appointed by the present Ministry of Commerce as Chairman of the new Committee. Since then the Commitee has met at frequent intervals mostly in New Delhi; one session was, however, held in Nagpur and the concluding session at Bangalore last month.

I have, now, the privilege to submit this final report of the Committee.

With kindest regards,

Yours Sincerely,

R. N. VASUDEVA

Shri Manubhai Shah,
Minister of Commerce,
NEW DELHI.

CORRIGENDA

Page No.	For	Read
29 - Para 2 last line.	or	for
40 - Para 1 line 4.	lge	high
42 - 1st line	eat	that
54 - Para 6 line 7.	is	this
57 - Para 1 line 2.	esk	mesh
63 - Last para line 1.	election	reduction
85 - Para 4 line 4.		from
Para 4 line 5.	ups	groups
113 - Para 5 line 2.	*recommends*	*recommends*

****

CONTENTS

MAPS

CHAPTER I

INTRODUCTION

1.00 The export trade in Indian manganese ore has been passing through a period of recession from 1958 onwards. Exports which were valued at about Rs. 32 crores in 1957 dropped to a figure of Rs. crores in 1960 and later in 1963 declined to an all-time low level Rs. 8·00 crores. The situation, as it developed became a matter of great concern to Government. It also came up for a general review at the periodical deliberations of the Board of Trade of the Ministry of Commerce. It was increasingly felt that besides taking short term measures, it would be desirable to make a comprehensive study of the problems of manganese mining industry with particular reference to the need for reducing costs in the face of growing competition from other manganese producing countries. It is against this background that the late Ministry of Commerce and Industry in consultation with the then Ministry of Mines and Fuel (now Department of Mines and Metals) constituted a special committee *i.e.* "Committee on Manganese Ore" under the Government of India Resolution No. 20(3)/63-BOT dated June 29, 1963.

The terms of reference of the Committee wereas follows:—

(i) To review and report on the present state of affairs of the manganese mining industry in all sectors such as mining, labour, transportation, port facilities etc. in so far as any of those aspects has a bearing on export of manganese ore,

(ii) To examine the projected developmental measures that are contemplated by the industry in the next five year period,

(iii) To study the nature and extent of the competition being faced by the industry in export trade in some of our principal export trade markets such as U.S.A., Japan and U.K.,

(iv) To examine, if feasible, the conditions obtaining in the countries which are our principal competitors and assess the impact of the developments in those countries in our own exports, and

(v) To recommend on the basis of (i), (ii), (iii) and (iv) above, appropriate measures for the rationalisation and modernisation of the manganese mining industry in its various sectors (such as labour, management of mines, blending and beneficiation, transportation including facilities at ports) with a view to securing a firm position for the industry in the foreign markets.

1.01 In accordance with the above resolution the following were designated as the members of the Committee :—

1. Shri M. Butt, Joint Secretary, Ministry of Mines and Fuel, New Delhi . . . . . . *CHAIRMAN*
2. Shri T. V. Rama Rao, Divisional Manager, State Trading Corporation of India Ltd., New Delhi . . . . *MEMBER*
3. Shri S. Rajagopalan, Director (Transport), Ministry of Commerce & Industry, New Delhi *MEMBER*
4. Mr. R. S. Stead, Managing Director, Manganese Ore (India) Ltd., Mount Road Extension, Nagpur . . . . *MEMBER*
5. Shri S. Lal, care of S. Lal & Co. (Private) Ltd., 15, Chittaranjan Avenue, Calcutta-13 . . *MEMBER*
6. Shri J. C. Gandhi, Western India Trading Company, 5th Floor, Nanabhai Mansion, Sir Phiroz Shah Mehta Road, Bombay-1 . . *MEMBER*
7. Shri A. M. Hussain, Deputy Mineral Economist, Indian Bureau of Mines, New Delhi . *SECRETARY*

1.02 On the transfer of Shri M. Butt from the Department of Mines and Metals, Shri R. N. Vasudeva was appointed Joint Secretary, Department of Mines and Metals in the Ministry of Steel and Mines on 1-6-1964. Shri Vasudeva took over the duties of the Chairman of this Committee *vide* Government of India Resolution No. 30(3)/63-BOT, dated October 28, 1964. Shri H. P. Sathaye, Director of Transport, Ministry of Commerce was included in the Committee in place of Shri S. Rajagopalan, *vide* Resolution No. *ibid.* Mr. R. S. Stead, Managing Director, Manganese Ore India Ltd. resigned from the membership, as on retirement from company's service he left India for United Kingdom. Shri K. Sadagopan, Director, Khandelwal Ferro Alloys Ltd., New Delhi, was also included in the Committee, *vide* Resolution No. 20(3)/63-BOT, dated 11th March, 1964. The composition of the reconstituted committee which started functioning from the middle of November 1964 was as follows :—

1. Shri R. N. Vasudeva, Joint Secretary to the Govt. of India, Ministry of Steel and Mines, New Delhi . . . . *CHAIRMAN*
2. Shri T. V. Rama Rao, Divisional Manager (Ores), Minerals and Metals Trading Corporation of India Ltd., Express Building, New Delhi . . . . *MEMBER*
3. Shri M. P. Sathaye, Director (Transport), Ministry of Commerce, New Delhi . . *MEMBER*

4. Shri S. Lal care of S. Lal & Co. (P) Ltd., 15, Chittaranjan Avenue, Calcutta . . . *MEMBER*

5. Shri J. C. Gandhi, Western India Trading Co., 5th Floor, Nanabhai Mansion, Sir Phiroz Shah Mehta Road, Bombay-1 . . . *MEMBER*

6. Shri K. Sadagopan, Director, Khandelwal Ferro Alloys Ltd., New Delhi . . . *MEMBER*

7. Shri A. M. Hussain, Deputy Mineral Economist, Indian Bureau of Mines, New Delhi . *SECRETARY*

1.03 For its studies of various problems relating to manganese industry the Committee proceeded to collect the requisite data from all knowledgeable sources within the country and published material available from other countries also. For example, factual information was made available by various mining interests in response to a questionnaire issued by the Committee on the nature and extent of deposits, the types of mining employed by them, analysis of cost etc. Principal mine-owners, Government departments and mining associations were specially interviewed and valuable material relating to the various aspects of the enquiry was obtained. Visits were arranged to some important mining centres such as Barajamda, Nagpur, Mysore, Bombay and Goa and important ports of discharge, such as Visakhapatnam, Calcutta, Madras, Bombay and Marmugao.

A questionnaire was also sent to the producers and exporters of manganese ore, mining associations, State Governments and Central Government departments. Discussions were held with different mining interests in Barajamda (Orissa); Nagpur (Maharashtra); Goa; Bombay; Bangalore and Londa (Mysore State.) Field studies of certain representative manganese mines and deposits were also carried out. For a study of conditions in ports, the Committee visited Bombay, Marmugao, Madras, Visakhapatnam and Calcutta ports. Tours for inspection of important railways sidings and loading points were also arranged. General discussions were held with State Government officials of Orissa, Bihar, Mysore, Bombay and Goa. Problems of port handling came up for special discussion with concerned port authorities.

In course of discussions with representatives of State Governments the Committee got an opportunity to bring to their notice certain pressing problems that required immediate attention *e.g.* construction and repairs of roads in certain mining areas, simplification of administrative forms and mineral disposition rights etc. Similarly the difficulties of industry regarding stacking, movement and loading of ore were discussed with port authorities who were good enough to accept the suggestions of the Committee for a few short term remedial measures.

1·04 In regard to the conditions in the world market, the Committee felt that several factors which were partly economic and partly political were operating. New captive mines in Brazil, Gabon, Morocco

etc. had been developed lately by a number of steel companies in collaboration with the Governments of the concerned ore producing countries. The production from these mines had already made inroads into the export markets of Indian ore. Other traditional competitors such as Russia, Ghana, Central Africa and South Africa had stabilised their markets to an appreciable extent. U. S. A., U. K., France, Belgium, Italy, Sweden and West Germany are India's traditional markets. In almost all these countries, India's share in their import trade had appreciably declined and other sources of supply had gained ground. The Committee studied mining, beneficiation, transportation and port handling procedures of other important manganese producing countries. Consumption patterns of manganese ore in the consuming markets, the extent and nature of their special requirements and the reason for their switching over to the other sources of supply were also assessed. The bulk of material was collected from published and unpublished reports available to the Committee. Factual data and also the assessments available with the Indian Bureau of Mines, Minerals and Metals Trading Corporation of India Ltd., Geological Survey of India and the National Metallurgical Laboratory were also used.

REPORT

1.05 The present report has been prepared by the Committee on the basis of the studies mentioned in the preceding paragraphs. The report is divided into ten chapters detailing each aspect of the industry *viz.* resources of manganese ore, characteristics of ores, uses and specifications, mining, mines management and mine financing, transportation and port handling, beneficiation and blending, mining legislation and fiscal levies and marketing. The conclusions and salient recommendations of the Committee which were formulated after carefully evaluating various geological, mining, metallurgical and marketing data, have been listed at the end of each chapter and also for facility of reference brought together at one place in the summary contained in the last chapter.

ACKNOWLEDGEMENT

1.06 The Committee is grateful to the Director General, Geological Survey of India, Director, Indian Bureau of Mines, Director, National Metallurgical Laboratory, officers of the Minerals & Metals Trading Corporation and National Mineral Development Corporation for providing necessary statistical and other useful factual data which constitute the raw material of this report. The Committee would also like to thank the mining interests, representatives of State Governments and port authorities for their ungrudging assistance and cooperation in the deliberations of the Committee at various stages. The Committee would, in particular, like to acknowledge its indebtedness to Shri A. M. Hussain, Secretary of the Committee for his unremitting industry in collecting data from various sources and marshalling it for preparation of numerous preliminary studies which necessarily preceded the writing of this report.

CHAIRMAN

1. Shri R. N. Vasudeva, Joint Secretary to the Govt. of India Ministry of Steel & Mines, (Department of Mines & Metals) New Delhi.

MEMBERS

2. Shri T. V. Rama Rao, Divisional Manager (Ores), Mineral and Metals Trading Corporation of India Ltd., Express Building, New Delhi.
3. Shri M. P. Sathaye, Director (Transport), Ministry of Commerce, New Delhi.
4. Shri S. Lal, C/o S. Lal & Co. (P) Ltd., Calcutta.
5. Shri J. C. Gandhi, Western India Trading Co., Bombay.
6. Shri K. Sadagopan, Director, Khandelwal Ferro Alloys Ltd. New Delhi.

SECRETARY

7. Shri A. M. Hussain, Deputy Mineral Economist, Indian Bureau of Mines, New Delhi.

CHAPTER II

WORLD RESOURCES OF MANGANESE ORE—A SURVEY OF RESERVES IN INDIA AND OTHER COUNTRIES

2.00 Geographical distribution of manganese ore, like that of other valuable minerals, is not uniform. Although occurrences of manganese ore are found in more than thirty countries, over seventy per cent of the entire resources of this mineral are accounted for by U.S.S.R., the remaining thirty per cent being shared among countries like India Brazil, Ghana, Union of South Africa, Morocco, China and Gabon. It is estimated that the total world reserves of shipping grade manganese ore (+35%Mn.) are of the order of 1,000 million tons. An attempt has been made in Table I at the end of chapter to indicate the distribution of the world resources of manganese ore among various manganese producing countries. These figures, however, are only an approximate indication of the actual mineable reserves at present, because the number of mines covered by these estimates would have undergone further development or depletion of reserves through intensive mining since these statistical data were obtained. However, the prospects of locating additional reserves of manganese ore are fairly bright and, in fact, extensive exploration and prospecting operations in a number of countries are already in progress. During recent years, extensive new deposits of manganese ore have been located in countries like Brazil, Gabon and Angola and large scale mines equipped with modern machinery have been established.

A brief resume of the manganese deposits in each of the important manganese producing countries is given in the following paragraphs:—

2.01 Union of Soviet Socialist Republics

Recently in Russia, sizeable new manganese deposits have been discovered, but the old Nikopol deposits in Ukraine, and Chiature deposits in Georgia which have been worked for a long time continue to be the most important sources. New manganese mines are found in Northern Urals, Central Kazakistan and Eastern Siberia. The main sources of supply of ore to the metal works of Urals are the mining areas of Serov and Ivdel. The well-known deposits of manganese and mixed ores of iron and manganese in Kazakistan are the Karajala, Boshoi Kti and Jazdi fields. Western and Eastern Siberia possess chiefly carbonate manganese ores. The largest are the Mazulsk and Usinsk manganese deposits which are used by the Kuznetsk iron and steel works. There are plans for extensive prospecting for manganese in the Eastern regions of USSR with a view to locating a source of supply of ore for the metallurgical enterprises of Eastern Siberia.

Nikopol deposits are located in the Southern Ukraine on the right bank of the Dnioper river, below the turn of Zaporozhe. The western field, 12 miles long by 6 miles wide contains the Alexandrovski group

of mines. In the eastern field five separate ore-bodies of the same type have been outlined. The area containing manganese ore is said to extend over 150 sq. kilometres. The manganese ore occurs as nodules, oolites and concretions in a horizontal bed 3-12 ft., thick and averaging 6½ ft. of palaeozoic marine sediments, mainly sedimentary clays. The bed rests on the basement of precambrian granite. The ore is mainly pyrolusite and contains, on an average 30 per cent manganese as mined which is concentrated to 33-57 per cent manganese with about 75 per cent of recovery. Reserves of all classes of ore have been estimated at 396,000,000 tons containing about 121,000,000 tons of manganese metal. The Nikopol manganese ore field has been considerably extended during recent years ; to the east this deposit passes into large carbonate deposits of Boloshoi Tokmark. These areas are known now as the large Nikopol manganese basin. Technological advances have recently been credited with increasing manganese ore production from this area. The Seventh Five Year Plan calls for doubling the production by 1965 to about 10 million tons per annum. The Chaklovskaya Mining and Processing Combine in Nikopol field will be the largest manganese undertaking in the U.S.S.R. It will comprise three open cast mines, a seven storey concentrator and a manganese agglomeration plant. A fully automated design incorporating remote control cutter loaders, conveyors and hydraulically operated pit props has recently been completed.

Chiature deposits are on the south slope of the Caucasus mountains of Georgia at an altitude of 2,000 to 2,500 ft. The deposits are very extensive and occupy an area approximately 19 miles by 5 miles. The Kvirila river flows through a deep canyon in this area. The mining area is serviced by an aerial tramway to a 21 miles spur of the main line of the Trans-Caucasus railways which carries the ore to Batum (126 miles) or Poti (90 miles) on the Black Sea. Chiature is the largest known single manganese deposits in the world and largest single producer of high grade ore. The associated rocks are sandstone, shales and chalk of Cretaceous to Miocene age. They are irregularly bedded, dipping gently towards north-east. The entire manganese bed averages 6 to 7 ft. in thickness. The ore consists of minerals like pyrolusite, psilomelane, braunite in lumps and wad. The ores are, however, generally friable, tending to be powdery. Grade is uniformally 48-49 per cent. Mn. Top grade is 52 per cent. Mn. When the ore is beneficiated, the concentrates may contain 80 to 90 per cent. Mno_2. These deposits yield dioxide ore, used for both battery and chemical purposes. Total reserves are of the order of 160 million tons containing 78 million tons of manganese. It is planned to double the production of this area also by 1965.

A plant for processing manganese waste is being installed and is expected to produce large tonnage of metallic manganese from dumps at Chiature and Nikopol.

·02 **Brazil**

Managnese deposits of large magnitude are known to occur in the state of Minas Geraes, Bahia, Mato Grosso and the territory of

Amapa. The average distance of these locations from Rio-de-Janeiro is about 300 miles by rail. The Bahia deposits are considered to be small. A large deposit of manganese ore, having manganese content of about 48 per cent has been found recently at Alto Jari, Para. There are two mining areas in Minas Garaes, one at Queluz (Lafayette) and the other at Miguel Burnier. In Minas Geraes, the ore occurs in a granite-gneiss-schist complex. In Miguel Burnier ore is found in the metamorphosed sediments overlying the complex. At Queluz the ore bodies are scattered throughout the complex with no definite pattern. The primary minerals are rhodocrosite, spessartite, rhodonite and tephroite, psilomelane and wad with pyrolusite.

In the Miguel Burnier district the occurrence is somewhat different. The ore is found as fairly definite beds and lenses in a sedimentary series. The principal bed is 2 to 3 miles in length and reaches a thickness of over 6 ft. Dip is steep towards north or south. Because of the structure and thickness of the beds, mining has to be done underground. The ore is largely a fine grained mixture of Psilomelane and Pyrolusite averaging 50 per cent Mn., 1 per cent. SiO_2 and 0·03 to 0·05 per cent P. With the advent of export shipment from Amapa, the production of Mines Geraes will be channelled still more to local consumption in nearby steel and ferro-alloy plants.

The deposits at Morro du urucum are among the largest in the world. Current reserve estimates are not available. A reserve of 34 million tons averaging 45·6% Mn is indicated. Large scale development here is hampered by the location. To reach the sea, 1800 mile trip barge down the Paraguay River or the less favourable alternative of a rail haul exceeding 800 miles will be necessary.

Amapa is situated north-west of Amazon mouth, and is connected by 121 miles long rail-road to Macapa on the north bank of Amazon river where transfer to vessels takes place. The reserves at Amapa are estimated by drilling at more than 14 million tons of ore with 45 to 47 per cent manganese in the two-thirds of the zone explored. Additional reserves are reported to have been discovered recently underlying the known deposits at Amapa mine which is the largest producer in the western hemisphere. The Amapa mine is operated by Komi, a Brazilian concern with which Bethlehem Steel (USA) is associated. The Amapa ores have recently been classified as type A chemical grade.

2·03 U.S.A.

Manganese deposits have been reported in 35 states of the country. However, no deposit comparable in size and grade to those found in the major producing countries of the world has been discovered. There are several large deposits of low grade material containing large quantities of manganese that could be recovered only under conditions of improved technology.

2·04 **Cuba**

Although manganese ore deposits have been reported from all six Cuban provinces, only the deposits of Oriente have produced any appreciable quantity of ore, and the Charco Redondo, Ponupo and Quinto mines have been the largest producers. In Oriente, the principal deposits occur as manganese oxides in or near the Charco Redondo limestone. Total Cuban production from 1888 to 1958 is estimated to be about 5 million short tons. In late 1958 for political reasons the mines were closed but later re-opened under orders of the new Government.

2·05 **Union of South Africa**

The Union of South Africa possesses large reserves of manganese ore ranging from manganiferous iron ore to high grade ore. The exported ore have a low silica content generally between 2·5 and 4·5 per cent. The chief deposits are in the Postmasburg area, Griqualand, Cape Province, about 108 miles west north west of Kimberley and about 739 miles from Durban Port.

The ore was originally traced for about 40 miles along the Gamagara ridge. Subsequently deposits were discovered in the neighbouring Klipfontain hills. These have since come to be known as western and eastern belts respectively. In the western belt, the deposits are inter bedded, at various horizons, with dolomitic rocks. In the eastern belt the ore occurs as disconnected mass varying greatly in size and shape and scattered irregularly through a cherty breccia. The irregularity of occurrences of ore body in all directions makes the estimation of reserves hazardous.

Two types of ore occur; one consists mainly of Psilomelane and the other braunite and Psilomelane. The ore is generally of good quality and is hard. According to a recent estimate total reserves are 100,000,000 tons, 15 million tons Ist grade (50% Mn.) and 85 million tons of other grades but may be much more. In 1962, a new high grade mine was opened by South African Manganese Co. near its Motaz property in the Koruman district. This ore will be supplied to African Metals Co. (Amcor), a major South African ferro-Alloy producer, for production of higher grade ferro-manganese intended mainly for export markets. The production of manganese ore in 1962 was 1,614,599 tons.

2·06 **Gabon**

Very promising deposits have recently been discovered at Moanda, Gabon (formerly French Equatorial Africa). The Moanda mines were opened on October 2, 1962 and in the last 4 months of 1962, 203,000 tonnes of manganese ore were produced. Maonda deposit is one of of the largest and richest deposits of the world. Reserves of the order of 200 million tonnes of ore of 50 percent manganese content have been estimated. The Compagnie Minerie de logone (Comilog) was formed in 1963 to exploit these deposits. In this company U.S. Steel has a major interest. The output was scheduled to reach 400,000 tons to

500,000 tons per year by 1963. This development project involved construction of a 170 miles ropeway from Franceville (M Binde railhead) to Ponte Noire, the main Congo port and a 48 miles cableway from the railhead to the mine.

2·07 Morocco

Manganese ores are found and mined in two distinct regions of French Morocco, in the eastern part near the Algerian border, and the southern part on the south flank of the Atlas mountain. Reserves have been variously assessed at about 30 million tons for both regions, of which 10 million tons are proved ore. The lead content of the ore is high and the ores are friable. The mines at Imini in the south are the largest producers. The chemical grade ore is mined at the surface but most of the metallurgical grade ore is produced from underground operations. The metallurgical grade ore is concentrated to a 50% manganese, low iron product, part of which is sintered to obtain 65 per cent. manganese sinter, low in iron but having an appreciable lead content.

2·08 Congo

Reserves of ore in Congo are in the neighbourhood of 10 million tons with 45 per cent. manganese content. After the construction of railway line to the Kingse mine in Katanga in 1951, Congo entered the world manganese market. Production of marketable ore rose to 300,000 tons in 1962. On January 31, 1962, Beceka-Manganese set up another company, the Societe Miniers de Kisange with a capital of 500 million francs. In October, 1962, Beceke-Manganese also participated in the formation of Societe Europeenee des Derivers da Manganese ("Sedema"). Sedema's main business is the manufacture of manganese compounds and the manganese metal for the entire European market. The company's plant will be erected near Tertre, in the province of Hainant, Belgium.

2·09 Ghana

Ghana has the distinction of owning most of the world's reserves of Battery grade and type-B chemical grade ore. The manganese deposits of Ghana are associated with meta-morphosed manganiferous sediments, some of these being similar to the gondites of India. Although manganese ore occurs in several regions, the output of ore has come entirely from the deposits at Nsuta—Dagwin, which is favourably located, at a distance of 39 miles from the port of Tekoradi (Sekondi). The ore is mainly pyrolusite and psilomelane and occurs as lenticles within a manganiferous horizon. These lenticles are capped by surface deposits. The lenticles are known to extend to a depth of at least 400 ft. and outcrop along a ridge for 2·5 miles.

The reserves are stated to be of the order of 12 million tons of 50 per cent. manganese. But this appears to be a very conservative estimate. At present the African Manganese Ore Co. and the Geological Survey Department are engaged in the full scale exploration of the Nsuta deposits.

2·10 Oceania

Recently production from Australia, Fiji, New Caledonia, New-Zealand, Papua has increased considerably. New deposits of manganese ore, including some of high grade have been discovered at the eastern end of the Pilbara field. Union Carbide Corporation has obtained prospecting rights in Western Australia and started exploration for setting up a large manganese mining enterprise.

2·11 Spain

Deposits of manganese ore are in the provinces of Ciudad-Real, Gerona, Huelva, Murcia, Oviedo, Sevilla and Teruel. Also manganiferous iron ore containing 10-20% manganese and 20-25% iron is found in the provinces of Murcia near Cartagena.

Huelva deposit, mostly high grade ore, at one time extensively mined, is now exhausted. The grade now mined in Spain is +30 per cent manganese.

2·12 China

China has considerable deposits of manganese ore. The Hunan deposits are of sedimentary origin and the best grade ore contains 43-46% manganese. Manganese ore is also found in the province of Kunangsi, Kuangtung and Kiangsi. Reserves are estimated at 29 million tons, 20-50% manganese. According to a recent report the reserves are believed to be between 50 and 100 million tons with a substantial part averaging 40 to 50 per cent manganese. For a country of its size, the manganese resources of China are not large; perhaps, this is because much of the western areas have not been prospected thoroughly.

2·13 Japan

The ores occur as small irregular mass in sedimentary rocks in many localities, *i.e.*, Hokkaido, Kyoto, Gifu, Aomori, Oita, Tochigi, Nagano and Shidzuoka. The total reserves are, however, scanty.

2·14 Philippines

Manganese deposits in the Philippines are scattered but are of fairly high grade. Reports for 1957 showed the four major producers to be : Zambales Base Metals, with deposits on Siqnijor Island (just south of Cebu) having reserves of 33,000 short tons; General Base Metals, Inc with reserves at Guindulman, Bhol Island amounting to 77,000 tons positive of 38-48% manganese direct shipping ores and 1·7 million tons of earthy ores containing 10% manganese; Jacel Mining Corporation, with reserves of 55,000 tons of direct shipping ore near Coron on Busuango Island; and Palawan manganese mines, Inc, with reserves estimated at 55,000 tons containing 48-50 per cent manganese; also near Coron, Busuanga Island, Northern Luzon Mining Co. has estimated reserves of 33,000 tons averaging 54 per cent manganese. Philippine Base Metals has estimated reserves of 28,000 tons of direct shipping or (48% or better) in Capas, Tarlac

Province, Luzon. Consolidated Philippines ore has reserves of 55,000 tons containing 40 to 50 per cent manganese and Laur Manganese Mines 28,000 tons plus 55,000 tons probable.

2·15 **India**

The important deposits of India are located in Madhya Pradesh, Maharashtra, Orissa, Mysore, Gujarat, Andhra Pradesh, Rajasthan and Bihar. Of these, the manganese belt of Nagpur-Bhandra-Balaghat districts of Madhya Pradesh and Maharashtra is most important from the point of view of quality and also the extent of reserves and actual production. Next in importance is Keonjhar-Bonai manganese belt of Orissa. In the Keonjhar-Bonai belt of Orissa and in Shimoga-Chitaldrug-Tumkur-Sandur-North Kanara district of Mysore, manganese and iron ores occur in the same field. Ores generally suitable for the manufacture of ferromanganese are found in Nagpur-Chindwara-Balaghat-Bhandra belt of Madhya Pradesh and Maharashtra and also in Shimoga-Chitaldrug-Tumkur, Bellary and North Kanara belts of Mysore.

(*a*) *Maharashtra/Madhya Pradesh :*

The manganese ore deposits of Chindwara, Nagpur, Bhandara and Balaghat districts of Madhya Pradesh and Maharashtra occur in an arcuate belt 130 miles (209 km) long and 16 miles (25·75 km) wide. There are more than 200 individual deposits within the belt, of which 20 are major producing deposits. The reserves of run of mine ore containing 30 to 40 per cent manganese are estimated at 12 million tons (12·2 million tonnes) per 100 ft. (30·5 m.) down dip extension in the 17 major deposits along the belt. Both measured and indicated reserves in these deposits are estimated at 20 million tons (20·3 million tonnes). Inferred reserves are of the order of 142 million tons (144·3 million tonnes) of ore out of which 75 million tons (76·2 million tonnes) are, probably, of metallurgical grade with 48% manganese content. Characteristic features of these ores are their low iron content and lumpy nature.

The dimensions of deposits and their reserves with an average grade of ore of 30 to 40 per cent manganese are given below :—

Name of Deposit or Mine	Length of Deposit (in ft.)	Average thickness (in ft.)	Reserves per 100 ft. down dip (100 ft. =30.5 m)	Measured and indicated reserves (*i.e.*, ore blocked out in mine plus ore below for 100 ft. dip extension)	Total inferred reserves assuming apex at ½ outcrop (limiting maximum dip extension 3000 ft.)
1	2	3	4	5	6
		NAGPUR DISTRICT			
Kandri . .	750	50	500,000	500,000	1,500,000
Mansar . .	11,000	25	2,500,000	3,000,000	41,250,000
Mandri . .	2,000	4	75,000	75,000	400,000
		BHANDARA DISTRICT			
Sitasongi . .	3,500	15	583,000	1,000,000	4,600,000
Chikla . .	2,500	8	200,000		1,250,000
Chikla Extn. and Okes . .	7,930	8	750,000	750,000	10,570,000
Dongri Buzurg .	4,500	28	1,300,000	2,750,000	15,750,000
		BALAGHAT DISTRICT			
South Tirodi .	5,600	15	900,000	1,300,000	11,760,000
W. & N. Tirodi .	..	6	500,000	100,000	2,500,000
Sukli . .	..	..	100,000	50,000	250,000
Ramrama W. .	1,150	13	160,000	100,000	425,000
Shodhan Hurki .	1,000	15	150,000	150,000	325,000
Netra .	1,500	20	300,000	500,000	1,125,000
Bharweli . .	8,400	16	1,500,000	5,250,000	22,400,000
Ukwa-Jagantola .	20,800	6·5	1,716,000	3,750,000	22,500,000
Ghondi . .	3,000	5	166,000	160,000	1,250,000
Laugur .	7,300	3·5	274,000	274,000	4,260,000
		TOTAL	11,674,000	19,709,000	142,115,000
			(11,861,335 tonnes)	(20,025,267 tonnes)	(143,395,500 tonnes)

(*b*) *Orissa :*

In Singhbhum-Keonjhar-Bonai manganese field the bulk of the reserves are in Orissa; those in Bihar are of secondary importance. Most of these deposits are shallow and do not extend below the water table. Since the ores are intermingled with lateritic and other gangue materials, recovery of high grade ore is low compared to the Madhya Pradesh-Maharashtra belt. Only 30 per cent of the ores have a manganese content of 40 per cent and above. The ores are generally low in phosphorous, but high in iron. A few deposits consist of dioxide ore of chemical and battery grades with 97 per cent MnO_2 content. Important deposits are at Nalda-Jamda, Belkundi, Barbil, Bhadrassi, Bonai, Koira, Joda, Kalimati, Dhubhna and other places in Keonjhar, and at Malda, Kalmang, Patmunda and Bhutra in Bonai. Total estimated reserves are of the order of 4·5 million tonnes of which 30 per cent of the ore has manganese content of 40 per cent and above. Probable reserves are of the order of 20 million tonnes.

The Koraput-Kalahandi manganese belt of Orissa is 20 miles (32 km) long and 2 miles (3·2 km) wide. Important deposits are at Kutingi, Nishkal, Podakona, Lillingumma, Pullabadi, Taldoshi and at a few other places. Only the Kutingi deposits which are easily accessible are being worked. About 25 per cent of the ores have a manganese content of 40 per cent and above, the rest are of low grade and ferruginous. Phosphorus content varies from 0·1 to 0·36 per cent. Probable reserves of the belt are of the order of one million tonne.

In Bolangir-Patna district of Orissa, the deposits at Bhaludungri, Gadshankar, Satparliadungri, Kapilbahal, Kuariapali and Karriamanga are important. In the ore manganese content varies from 25 to 34 per cent; iron oxide from 23 to 34%; silica from 7 to 10% and phosphorus from 0·22 to 0·53%. The reserves are estimated at 0.61 million t onnes.

Around Kandhal (21°3′ : 84°10′) in Rairakhol in Orissa the reserves of three small deposits with manganese content of 25% are estimated at 60,900 tonnes.

In Bamra area some manganiferous iron ores and ferruginous manganese ores are recorded but no workable deposit has been noted.

(*c*) *Andhra Pradesh :*

Manganese-ore deposits in Srikakulam district, Andhra Pradesh, occur along four main NW-SE trending belts :(1) a southern belt comprising the quarries of Kodur-Davada and Chinna Bantupalle, (2) a south central belt covering the quarries of Garbham, Vedullavalasa, Avagudem, Chipurpalle and Perapi, (3) a north central belt including the quarries of Aitemvalasa, Gadabavalasa, Batna, Karlam and Nimmalavalasa and (4) the northern belt consisting of the quarries of Gotundi, Garuja and Joda. The ore is generally low grade containing, on an average, 36 per cent manganese, 14 per cent iron, 12 per cent

silica and 0·25 per cent phosphorus. The ore from Kodur-Garbham-Aitemvalasa area is generally low in phosphorus and high in iron, whereas that in Ramabhadrapuram area is high in phosphorus and low in iron. The reserves are estimated at 0.51 million tonnes over the entire belt.

(*d*) *Mysore :*

The manganese-ore deposits of Shimoga, Chitaldrug and Tumkur districts in Mysore are distributed in eight main areas : (1) Shankaragudda, (2) Kumsi, (3) Shikarpur, (4) Channagiri, (5) Shiddanhalli, (6) Chiknayakanhalli, (7) Kare Karichi and (8) Kondi. The ores are generally of low grade containing 35 to 45 per cent manganeses with low percentage of phosphorus. The reserves are of the order of one million tonne.

The manganese ore deposits of Sandur, Bellary district in Mysore State are distributed over a distance of 20 miles (32 km) extending from Ramandrug in the north-west to Kammadheruvu in the south-east. Ramandrug deposits are practically exhausted except for some very low grade left out in the workings. Active mining is now being done in Kammadheruvu-Kanavehalli regions south of the main Sandur-Kerdling road.

The average grade of ore varies from 32 to 35 per cent manganese, although local concentrations of high grade ore averaging 50-52 percent manganese ore are not uncommon. The range of analyses is given below :—

Mn	39·47 —54·39 %
FeO	5·38 —19·4 %
SiO_2	0·3 —1·0 %
P	0·016 —0·033%

The ore reserves are of the order of 0·8 million tonnes.

Manganese ore deposits of North Kanara and Belgaum occur in five different belts in an area of 170 sq. miles in Supapetha and Khanapur Taluks. Deposits in Supapetha contain sizeable reserves. On a preliminary examination, the reserves of the entire areas are estimated at 10 million tonnes, half of which are of workable grade. The iron content of the ores is generally high, but silica and phosphorous are remarkably low.

(*e*) *Gujarat :*

Manganese ore deposits in Panch Mahals and Baroda districts, Gujarat, occur at four places near (1) Shivrajpur, (2) Bamankua, (3) Talaori and (4) Parri. The Shivrajpur zone extends in a E-W direction from Bapatia to Shivrajpur mines for a length of 5,000 ft. (1,524 m) and extends for another 2 miles (3·2 km) in a northerly direction from Shivrajpur. The reserves of manganese ore with an average manganese content of 46% are estimated at 1·73 million tonnes. The Bamankua zone is 3,500 feet (1,067 m) long. The reserves of the ore with 43 to 45 percent manganese content are estimated at 0·3 million tonnes.

The Parri zone is about 2 miles (3·2 km) long with estimated reserves of about 0·5 million tonnes. Besides these, major deposits of manganese ore also occur at Gandhra, Val, Bhabar, Anas, Ambala and Jothward.

(*f*) *Rajasthan :*

In Rajasthan, manganese ore deposits occur mostly in Banswara and Udaipur districts and a few in Jaipur district. The ore is generally of low grade ranging from about 28 to 48 percent manganese content. The probable reserves are estimated at 2 million tonnes.

(*g*) *Goa :*

Important deposits of manganese ore are concentrated in Sanguem, Quepem and Canacona taluqs. Of these Rivona-Colomba deposits and those near Verlem-Salginen are by far the most important. On a tentative estimate reserves in Goa deposits are of the order of six million tonnes of manganese ore and ten million tonnes of ferruginous manganese ore.

Two commercial bi-metal ores are produced and marketed in Goa i.e. (i) manganiferous iron ore (popularly classed black iron) with manganese content going upto 15% and total metal content 50% (ii) ferruginous manganese ore (locally called ferro-manganese) with a minimum of 28% of manganese and total metal content of 50%.

The analysis of commercial grades of manganese ore from some of the important areas in Goa is as follows :—

Area	MnO_2	MnO	Mn	Fe_2O_3	Fe	Al_2O_3	SiO_2	P	S	H_2O
Rivona-Colomba	..	..	40·10	..	18·70	0·86	1·35	0·016	0·024	..
Do.	91·27	4·20	60·93	2·43	1·70	0·33	1·20	0·009	0·009	0·51
Do.	..	..	39·50	..	17·57	2·91	1·52	0·044	0·034	..
Natorlim	59·98	1·51	39·07	21·83	15·27	5·15	5·57	0·011	0·038	5·82
Verlem	..	..	47·50	..	11·10	0·10	4·10	0·024	0·012	..
Salginim	94·60	1·36	60·78	2·03	1·42	0·29	0·82	0·950	0·017	..
Do.	..	..	39·50	..	13·30	5·43	6·46	0·044	0·026	..

Some of these ores are of such high quality that with slight reduction in the iron content they could be utilised as chemical grade ore. Their suitability as battery grade should also be tested.

2.16 Conclusions

(i) Almost seventy per cent. of the world resources of manganese ore are accounted for by the USSR and the remaining thirty per cent are distributed among other countries mainly India, Brazil, Ghana, Union of South Africa, Union of Gabon and Morocco.

(ii) During recent years, large scale prospecting operations have been carried out in some of these countries which have resulted in considerable additions to the known resources of manganese ore. According to the Mining Journal Annual Review—1963, the manganese ore resources of the USSR were estimated at 2,000 million tonnes in 1961. This represents a great advance over the 1956 estimate of 550 million tonnes of 28-50% Mn.

The reserves of Amapa, Brazil are estimated at 14 million tonnes of ore with 45 to 47% Mn. Besides, additional reserves are reported to have been discovered recently below the known deposits at Amapa mine, which is the largest producer of manganese in the Western hemisphere. The Bethlehem Steel (U.S.A.) are participating in development and mining of these deposits.

Promising manganese ore deposits have recently been located at Maonda in Gabon. Reserves of the order of 200 million tonnes of ore of 50% Mn have been estimated. The exploration and exploitation is being done by the Compagnie Minerie de l'ogone (Comilog) in which U. S. Steel Company holds a major interest.

(iii) All major steel producing countries of the world with the exception of USSR and China continue to have either very poor or no resources of manganese ore.

(iv) The United States of America has several large deposits of low grade refractory material containing sizeable quantities of manganese which could be recovered only under favourable conditions of improved technology, higher prices or both.

2.17 Recommendations

1. Intensive exploration of manganese bearing areas in India is necessary for proving additional reserves. Government should accord high priority to exploration of manganese ore through the agencies of the Geological Survey of India, Indian Bureau of Mines and State Government's departments of geology in this respect.

2. Large scale mapping followed by exploratory drilling is the well established method. Geo-chemical and Geo-physical survey techniques hould be pressed into service where possible. Magnetic and gravity urveys conducted by the Geological Survey of India have yielded good

results in Madhya Pradesh and Andhra Pradesh. It will be useful if the results of these surveys could be made available to interested prospectors and mining interests through the medium of published monograms.

3. From the point of view of economics of exports, it will be desirable to accord priority to exploration of those deposits which are located near the sea coast, as for example in Mysore (North Kanara) and Goa. To meet the indigenous requirements of ferro-manganese producers and the steel plants, similarly, particular attention would have to be given to deposits located in close proximity to these plants. Some of these 'near plant' deposits could serve, with advantage as a captive source for the ferromanganese producers and the steel plants.

BIBLIOGRAPHY

1. Mineral Resources of U.S.S.R., Atropovo.

2. Material survey 'Manganese' United States Department of Interior, 1952.

3. Metallurgy of the Rarer Metals—3 Manganese, Sully, 1955.

4. The Geology of the Nsuta Manganese ore deposits by H. Service, 1943.

5. Mineral Facts & Problems U.S.B.M., 1960.

6. The Mining Journal—Annual Number, 1963.

7. Material supplied by the Director General, Geological Survey of India *vide* letter No. 2282/S/40, dated 19-1-1963.

8. United States Minerals Year Book, 1961.

Table I : World Reserves of Manganese ore by Countries

(Million Tons)

Country	Estimated Ore				Remarks
	High Grade		Intermediate		
	Tons	Grade	Tons	Grade	
1	2	3	4	5	6
North America					
Cuba . . .	1	45	1·2	±20	
Mexico . . .	5	+45	1	±25	
United States . .	1	+35	11	13	Low grade-3-10% Mn. is inexhaustible of the order of ±800 million tons.
South Africa					
Brazil . . .	60	38—50	..	..	Perhaps much more.
Chile . . .	1·2	+35	..	..	Recent figures not available.
Africa					
Angola . . .	0·4	48	3	..	High iron. Additional reserves likely.
Belgian Congo .	10	±45	..	..	
Egypt	..	..	±9	±25	Ferruginous manganese ore.
French Equitorial Africa	50	±48	..	..	Recent development; not fully explored.
French Morocco .	50	±45	20	±25	
Ghana . . .	12	±50	..	..	
Union of South Africa .	±60	32·50	..	..	Considerable potential. May be more than 1,000 million tons. Exploration continuing.

1	2	3	4	5	6
Europe					
Czechoslovakia .	..	..	4·5	18	Ferruginous Manganese ore.
Greece . . .	0·4	30·56	..	..	
Hungary . . .	4·5	±35	6	8·20	
Italy . . .	0·5	34·37	..	..	
Rumania . . .	..	..	7	14·40	
U.S.S.R. . . .	±550	28·50	±75	17·24	2,000 million tons is the estimate given in the Mining Journal, Annual Review—1963.
Yugoslavia . . .	0·5	32·38	..	..	
Asia					
China . . .	18	38·52	11	±20	*48% is estimated at 60 m. tons as against the previously accepted fig. of 25 m. tons. Potential of numerous scattered deposits have been estimated as high as 6 m. tons.
India* . . .	100	+40	..	..	
Manchuria . . .	..	..	3	—30	
Republic of Philippines	0·5	+35	..	..	
Turkey . . .	±1	30·50	..	..	
Oceania-Australia .	0·5	42·52	..	..	Excludes manganiferous iron at iron monarch.
TOTAL .	±900	..	±200	..	

Source:—Mineral Facts and Problems, U.S. Bureau of Mines, 1956 Edition.

CHAPTER III

PHYSICAL AND CHEMICAL CHARACTERISTICS OF MANGANESE ORE

3.00 It is essential to understand the physical and chemical characteristics of manganese ores in order to evaluate their suitability for various industries. This would help in focusing attention on the problems of home consumption of various grades of manganese and their export. For this purpose the available analytical data is not exhaustive but is generally adequate for the understanding of the problems affecting the manganese ore industry in India, and the export trade. Analyses of the U.S.S.R., Brazil, and Ghana ores which are the main competing countries are given below. Main constituents of Indian ores are also described in the following paragraphs :—

3.01 U. S. S. R.

Physical.—The physical nature of the Russian ores is, on the whole, soft. The Tchiaturi ores disintegrate readily into fines. The Nikopol ores, are, however, coarser and cleaner, but of low grade which require concentration. A general screen analysis of Russian ores is given below:—

Size	Percentage	Size	Percentage
4″	Nil	1	5½
3″	Nil	½	15
2″	Nil	¼	18
10 mesh	18	100 mesh	1
20 mesh	12	—100 mesh	2½
65 mesh	2		

Chemical.—Percentage Analysis of Tchiaturi ores

Constituent	Unwashed	Washed	Peroxide
1	2	3	4
MnO	11·8	18·8	1·5
MnO_2	63·1	62·4	82·2
Fe_2O_3	1·5	1·3	1·2

1	2	3	4
SiO_2	10·9	6·9	6·4
P_2O_5	0·36	0·33	0·47
Al_2O_3	0·9	1·1	1·2
Cao	1·9	1·4	1·7
H_2O	5·1	5·5	1·9
Equivalent to			
Mn	49·02	53·97	53·11
Fe	1·07	0·89	0·81
P	0·14	0·15	0·22

Percentage Analysis of Nikopol Ores

Constituent	First Grade	Second Grade
Mn	48·51	42·44
Fe	0·7— 1·2	1·5 —1·9
P	0·16—0·22	0·17—0·25
SiO_2	7·5—10·5	13·0—15·0
Al_2O_3	1·2— 1·6	2·0— 2·5

The ratio of manganese and iron will be roughly 50 : 1 in the Russian ores.

3·02 Brazil

Physical.—A general screen analysis of the Brazilian ore is given below:

Size	Percentage	Size	Percentage
4"	3½	10 mesh . .	3½
3"	1	20 mesh . .	1½
2"	5	65 mesh . .	¼
1"	6	100 mesh . .	.
½"	7½		.
¼"	40		..

Chemical.—Analysis of Brazilian ores imported into U.S.A.

Constituent	Percentage
Mn (dry)	45·00
Fe (dry)	5·00
SiO_2(dry)	7·50
Al_2O_3 (dry)	7·50
P	0·10
Moisture	10·50

The manganese content of the Brazilian ores is high. The Amapa deposits average 50% Mn. Mn : Fe ratio is also high, as much as 10:1. But slag forming constitutents *i.e.* $SiO_2+Al_2O_3$ are high as also the moisture content. It is also reported that the ores contain some residual impurities of Cu. 0.08%; Pb 0.02%; Zn 0.03%; As 0.14%.

3.03 A general screen analysis of the Ghana ore is given below:

Size	Percentage	Size	Percentage
4″	0	10 mesh	8
3″	0	20 mesh	6
2″	½	65 mesh	1½
1″	5	100 mesh	½
½″	26½	—100 mesh	1½
¼″	30		

Chemical.—Analysis of Ghana Manganese Ore (Percentages)

Grade	A	B	C	D
MnO_2	94·98	86·08	78·71	68·57
MnO	2·08	3·20	3·88	3·51
Fe_2O_3	0·14	2·29	5·72	11·01
SiO	0·30	2·45	4·60	3·55
P_2O_5	0·29	0·25	0·24	0·32
Al_2O_3	0·87	1·96	3·14	4·43
CaO	0·03	0·25	0·29	0·60
MgO	Trace	Trace	0·16	0·29
BaO	0·02	0·07	0·10	0·18
SO_3	0·04	0·02	0·10	0·21
TiO_2	Trace	0·09	0·10	0·18
H_2O+Co_2	0·70	3·32	2.65	4·87
Cl_2O_3	Trace	Trace	0·10	0·20
TOTAL	99·45	99·98	99·79	99·92

Equivalent to :

Grade	A	B	C	D
Mn	61·65	56·90	52·77	46·08
Fe	0·10	1·60	4·00	7·70
P	0·126	0·11	0·11	0·14
SiO_2	0·30	2·45	4·60	5·55

3.04 South Africa

Physical.—The screen analysis of ore imported into U.S.A. are given below :—

Size	Percentage	Size	Percentage
4″	8	10 mesh . .	1
3″	13	20 mesh . .	1
2″	20	65 mesh . .	½
1″	32	100 mesh . .	¼
½″	12	—100 mesh . .	¼
¼″	7		

South African ores are very hard and can thus withstand transport and storage without undue disintegration.

Chemical.—Analysis of Postmasburg ore (Percentage)

Grade	I	II	III	IV	V
Mn	50+	48—56	43—45	36—42	28—35
Fe	5—9	11—14	13—17	13—24	20—32

Bulk Analysis (Percentage)

Mn	52·21	50·38	48·95	47·22	45·93	43·28	42·97	40·14	36·68	34·40
Fe	8·67	10·14	10·02	11·92	12·42	15·33	16·03	19·51	18·75	21·30
SiO_2	3·90	3·05	3·40	2·29	2·87	2·77	2·45	2·78	2·80	3·21
P	0·049	0·055	0·045	0·035	0·044	0·043	0·040	0·060	0·039	0·034

3.05 India

Indian ores show a wide variety in their chemical composition. Generally these ores are fairly hard and lumpy and easily reducible. Such characteristics are favourable for the purpose of smelting. The following is the sieve analysis of the Indian ores generally exported to U.S.A.

Size	Percentage	Size	Percentage
4″	15	10 mesh	4
3″	12½	20 mesh	½
2″	16½	65 mesh	1
1″	20	100 mesh	½
½″	17		

Chemical analysis of both high grade and low grade ores have been indicated below. It will be seen generally these ores have an average low Mn : Fe ratio and high phosphorus content which are unfavourable for the manufacture of ferro-manganese. The manganese iron ratio of Indian ore is generally less than 7:1 against the Caucasian ore ratio of 50 : 1, Ghana 10 : 1 and Brazil 10 : 1.

(*a*) *Madhya Pradesh* :

High grade deposits in this state are located in Balaghat and Chindwara districts. Deposits of relatively lower grade are found in Jhabua and Jabalpur districts. Madhya Pradesh ores are lumpy, hard and compact in nature. Very high grade mixtures are obtained on blending ores from different mines. For example, the oriental mixture of Manganese ore (India) Ltd. has the following percentages of various constituents :—

Mn. 51.6; P. 0.1006; SiO_2 7.0; Fe 7.0

Detail information is not available in respect of the chemical composition of ores from all the areas where occurrances of manganese ore are reported. Composition of ores from certain important manganese producing areas is reproduced below:

Balaghat.—The chemical analyses of 13 samples from different mines in this district gave the following percentage range.

Manganese	49·08 to 54·51
Iron	5·28 to 9·10
Silica	1·62 to 6·02
Phosphorus	0·04 to 0·24
Moisture	0·12 to 0·85

Low grade ore extracted from mines in Maragpur, Balaghat district has the following Composition :

Mn%	Fe%	P%	SiO_2%	Al_2O_3%	Ba%	CaO %
34·45	2·19	0·098	17·72	8·51	2·08	2·30

Chindwara District.—The chemical analyses of nine samples from different mines gave the following range :

	(Percentage)
Manganese	48·95 to 54·97
Iron	5·00 to 11·77
Silica	4·98 to 10·63
Phosphorus	0·06 to 0·28
Moisture	0·00 to 1·27

The low grade ore extracted at Kachhindhana, Chindwara district generally conforms to the following composition :

	(Percentage)
Manganese	41·60
Iron	8·46
Phosphorus	0·20
Silica	14·60

Jhabua District.—The reef ore analyses are as follows:

	(Percentage)
Manganese	40—44
Iron	10—11
Silica	10
Phosphorus	0·25—0·3

Jabalpur District.—Analysis of three samples indicate the following range :

	(Percentage)
Manganese	34·53 to 56·80
Iron	1·60 to 10·30
Silica	1·40 to 4·79
Phosphorus	0·30 to 0·46
Moisture	0·32 to 0·90

(*b*) *Andhra Pradesh :*

Occurrences of manganese ore are concentrated in Chipurupalli and Salur taluks. The manganese content of the ores of commercial grade varies from 40—55%. These deposits are generally of inferior grade and have a high phosphorus content. Ores extracted from these deposits have to be blended with high grade ores from ther areas, before they can be sold in foreign markets.

Analysis of Ores from Andhra Pradesh

Locality	Manganese %	Iron %	Silica %	Phosphorus %	Aluminium %	Ba %	Ca %
Kodur mines	45-55	5-10	2-5	0·20-0·30 P_2O_5	..	..	..
Garividi (detrital ore)	42-49	16·63	3.66	0.14	..	..	..
				Remarks :	It is estimted that about 2 million tons of ore with 20-25% Mn. may be available in the dumps.		
Garbham main quarry.	40-49	7-15	3-10	0·35-0·55	..	..	..
				Remarks :	The analysis given is that of commercial grade ore. The average grade of ore belongs to 3rd grade, analysing, about 38—40% Mn. The accumulated dumps are estimated to contain about a million ton of ore containing 25—30 per cent manganese.		
Perapi, near Chipurupalli Rly. Stn. (Boulders).	26·68	14·72	16·66	0·23	..	..	..
Avagudem workings near Chipurupalli Rly. Stn.	39·41	13·30	4·73	0·44	..	..	..
Aitemalasa workings.	30-40	..	..	..	..	..	..
Sonapuram, Salur Taluk.	40.54	13·60	3·40	0·200	..	..	..
Mamidipalli (Itala Mamdipalli) Salur Taluk.	32·21	15·20	10·30	0.482	..	..	..
Bamkuruvalvsa Salur Taluk.	46·98	9·10	4·50	0·48	..	..	..
Peddapadem and Marlhondapunta, Salur.	30-40	..	12-15 (Si_2O & Al_2O_3)	0·20—0·30	..	..	..

(*c*) *Mysore :*

The manganese ores of Mysore State fall into generally second and third grades. Iron content is high and seems to exist in combination

3—1 I. B. M. (N. D.)/65

with manganese, both mechanically and chemically. Silica and phosphorus contents are remarkably low.

The analyses of Sandur ores mined by the Sandur Manganese and Iron Ores (P) Ltd. are:—

Grade "Sandur A" — 38-40 % Mn.
Mn. 40·29 % Fe 16·40% P 0·028 %

Grade "Sandur B" — 20-32 % Mn.
Mn. 29·55 % Fe 23·46 % P 0·049 %

Physical Properties
Lumps 4″ and above 55%
Rubbles 2″ and above 25%
Smalls ½″ and above 15%
Fines Less than ½″ 5%

The ores in Shimoga assay Mn. 35.53% Fe. 20.74% and SiO_2 1.86% with low phosphorous content. The Tumkur ores are reported to be high in Silica *i.e.* 15—20%.

The Mysore Iron and Steel Works, Bhadravati get their supplies of manganese ore from Kumsi and Gungur mines in Shimoga district for the manufacture of ferromanganese.

Chemical analyses of the ores from areas near Goida, North Kanara district were carried out by the Geological Survey of India. The results have shown these ores to have high Mn. content, but at the same time a high iron content. Manganese content varies from 15·79% to 53·79% and iron which occurs in chemical composition with the manganese minerals, ranges from 3·88 to 28·21%. Similarly silica varies from 1·38 to 7·95%. In case of manganese breccia and gritty ores, silica content is somewhat high going up to 12·30%. In breccia and gritty ores phosphorus content is very low varying from 0·02 to 0·114%, which are very acceptable limits for ferro-manganese industry.

(*d*) *Maharashtra* :

What has been said in regard to Madhya Pradesh ore more or less applies to Maharashtra ores also as Nagpur and Bhandara deposits are, virtually extensions of the Madhya Pradesh deposits.

Nagpur District.—The general grade of ore produced from this district contains the following :—

	(Percentage)
Manganese	42-52
Iron	5-7
Silica	11-18
Phosphorous	0·18-0·26

Bhandara District.—The chemical analyses of 13 samples from different mines in this district gave the following range :

	(Percentage)
Manganese	49·00 to 54·07
Iron	3.86 to 10·25
Silica	2·08 to 6·50
Phosphorous	0·06 to 0·34
Moisture	0·09 to 1·00

Ratnagiri ores contain 30% Mn. on the average.

(*e*) *Gujarat:*

Following is the percentage composition of Panch Mahal Ores.

Constituent	Grade I	Grade II	Grade III	Pyrolusite
Manganese	48-50	46-47	43-44	
Iron	4-5	5-7	6-8	2·3-3·5
Silica	6-8	9-11	12-14	
Phosphorus	0·23-0·26	0·24-0·28	0·24-0·27	..
MnO_2	..	..	..	80·82

(*f*) *Bihar and Orissa :*

In Bihar, manganese ores occur near Chaibassa. Generally, the ores are soft and rather waddy in nature mostly of low grade which are associated with phyllitic and schistose rocks and contain jaspery veins. Ore with 30 to 44% manganese content is generally hand picked or export.

Orissa ores represent a mixture of oxides and hydroxides of manganese and iron. Low phosphorus content of these ores is a note-worthy feature, although ores high in phosphorus are also found especially in Patna district. Occasionally, high grade metallurgical ores and in some places chemical or battery grade ores are also found.

Only 17% of the reserves of this state contain 45% manganese and above; low phosphorous content makes Orissa ores particularly attractive for indigenons use as also for export market.

Chemical analyses of some of the ores from Choraiajor, Gangpur has indicated the following range :

	(Percentage)	
Manganese	45·58 to 54·13	45·31 (Mean)
Iron	2·60 to 7·92	6·59 (Mean)
Silica	2·60 to 11·20	4·41 (Mean)
Phosphorus	0·061 to 0·250	0·117 (Mean)

Several manganese ores from Keonjhar have analysed as follows :—

	(Percentage)
Manganese	38·0 to 58·85
Iron	0·45 to 14·00
Silica	0·78 to 6·00
Phosphorus	0·075 to 0·15

Analysis of several samples from Bonai has disclosed the following composition :—

	(Percentage)
Manganese	36·15 to 59·00
Iron	1·12 to 11·22
Phosphorus	0·011 to 0·18
Silica	0·38 to 8·26

A small percentage of the manganese ore is of very low phosphorous content. The following is the average of several chemical analyses of such ores:—

	(Percentage)
Manganese	57·01
Iron	1·93
Phosphorous	0·0098
Silica	1·60

The following are the chemical analyses of several typical samples of manganese ore from Gadshankar in Patna :—

		(Percentage)	
Manganese	54·15	41·50	36·20
Iron	3·10	11·50	14·40
Phosphorus	0·372	0·377	0·456

Chemical analysis of Kutungi deposits, Koraput is indicated below:

		(Percentage)	
Manganese	51·35	53·52	55·42
Iron	5·02	3·91	1·12
P_2O_5	Nil	0·02	0·01
Insol	3·30	1·86	7·08

(g) *Rajasthan:*

The following is the analysis of the representative samples of the despatches of Rajasthan ores made during the past few years. The distinctive point to note is the relatively low phosphorus content of these ores *viz.* below 0.15%. Though the manganese content is not very high, the Mn-Fe ratio in several places is suitable for the manufacture of standard grade ferromanganese. The ores are rather high in silica.

Analysis of Rajasthan Ores

Sl. No.	Location of ore	Mn.	Fe.	SiO_2	P	Al_2O_3	Mn./Fe ratio
1	2	3	4	5	6	7	8
1	Deberi, Udaipur district	35·68	5·04	21·16	2·288	..	7·1
2	Sardarpur (Nathwara) Udaipur dist.	31·21	7·66	6·34	..	..	4·1
3	Itala, Banswara District	42·77	3·71	18·29	0·1147	3·33	11·5
4	Talwara ,,	44·47	1·78	1·48	0·0319	3·97	25·0
5	Talwara ,,	48·7	0·5	0·4	0·014	0·40	97·4
6	Talwara ,,	41·65	4·78	2·18	0·0337	1·90	8·7
7	Talwara ,,	41·25	5·99	2·39	0·033	1·10	8·9
8	Sagan ,,	40·71	13·32	10·39	0·3008	2·12	3·1
9	Itala ,,	41·73	3·09	25·81	0·1402	..	13·5
10	Itala ,,	44·91	4·30	16·87	0·138	3·08	10·5
11	Itala ,,	44·91	3·55	16·60	0·0814	3·05	12·7
12	Itala ,,	46·53	2·98	13·19	0·1481	2·47	15·9
13	Itala ,,	45·72	3·72	14·67	0·1245	2·80	12·3
14	Thikhi, Nathwara Udaipur dist.	39·80	3·85	14·5	..	..	10·4
15	Ramel ,,	51·7	2·1	2·25	..	..	24·6
16	Sironia, Banswara district.	44·17	3·66	18·26	0·055	3·14	12·1
17	,, ,,	43·09	3·18	20·78	0·092	3·35	13·5
18	,, ,,	43·6	2·99	22·98	0·0751	2·60	14·6
19	,, ,,	45·28	2·94	20·07	0·0706	2·70	15·4
20	,, ,,	40·64	3·60	26·73	0·0818	2·97	11·3
21	,, ,,	42·79	3·79	21·57	0·0829	2·15	11·3
22	,, ,,	42·59	4·47	20·75	0·110	2·71	9·5
23	Sagwa ,,	31·70	3·70	38·88	0·1934	5·35	8·6
24	Sagwa ,,	35·1	3·20	36·35	0·0196	7·75	10·97
25	Sagwa ,,	34·6	3·336	36·20	0·0741	6·10	10·3
26	Sagar Lankai . .	40·16	16·24	0·08	0·17	3·63	2·47
27	Sagar Lankai . .	42·93	11·67	8·52	0·09	3·06	3·7
28	Pandwal . . .	34·92	13·71	17·33	0·26	..	2·5
29	Tamberashra . .	38·18	2·83	30·76	0·1112	2·67	14·7
30	Tamberashra . .	41·20	2·80	27·70	0·180	1·00	13·4
31	Kalakhunta . .	40·82	4·50	24·85	0·112	3·57	9·0
32	Itala . . .	35·67	4·13	29·68	0·3345	..	11·1
33	Itala . . .	57·00	5·03	13·19	0·139	3·65	11·1
34	Itala . . .	43·52	2·79	22·75	0·130	3·18	15·6
35	Itala . . .	34·74	2·60	29·63	0·21814	3·14	11·0
36	Itala . . .	39·07	2·42	31·13	0·147	2·50	16·1
37	Itala . . .	40·85	2·42	28·28	0·134	3·33	16·8
38	Talwara . . .	42·40	1·00	0·85	0·024	2·5	36·0

3.06 Analyses of some low grade manganese ore samples on which beneficiation tests have been carried out at the Indian Bureau of Mines and National Metallurgical Laboratory are given below:

ANALYSES

Location	Mn%	Fe%	SiO_2%	P%	Al_2O_3%	CaO%	MgO%	S%	BaO%
Kachindhana mines, Chindwara dist. M. P.	41·6	8·46	14·6	0·20	..	..	..	..	..
Tirodi mines, Balaghat dist. M. P.	27·39	7·47	33·4	0·36	..	..	..	..	..
Netra mines Balaghat dist. M. P.	29·24	7·77	31·26	0·26	2·60	4·30	2·89	0·35	1·92
Mirajpur mine, Balaghat dist. M. P.	34·45	8·19	19·72	0·098	8·51	..	..	..	..
Kodur mines, A. P. (Alluvial ore).	33·94	4·53	14·01	0·49	8·5	..	..	..	..
Marivalasa mines, Salur A.P.	28·63	12·68	18·44	0·20	6·19	..	..	..	..
Kodur mines, A.P. (Bed Ore)	33·49	13·92	8·45	0·29	7·45	..	..	..	..
Chipurupalli A. P.	25·82	10·89	25·16	0·13	..	..	..	..	..
Shivrajpur mines, Gujarat	36·5	10·25	19·07	0·38	6·94	..	..	..	..
Mansar mines, Maharashtra	32·67	10·13	27·48	0·46	..	..	..	..	..
Nagri-goida (D-grade ore) North Kanara, Mysore.	34·71	18·49	3·93	0·03	6·70	..	..	..	..
Papeli mines, North Kanara, Mysore.	39·66	9·15	14·94	Trace	1·82	..	..	..	..
Sandur, Mysore	30·18	21·9	0·99	0·03	12·40	..	..	..	..
Keonjhar Orissa (TISCO ore) washed product.	27·7	31·6	2·8	..	4·86	..	..	..	..
Sagur, Orissa	29·06	17·98	1·78	0·052	14·40	..	..	..	..
Siljora, Keonjhar, Dist. Orissa.	37·55	12·46	7·56	0·086	6·45	..	..	..	..
Karwal Mines, Orissa	31·37	24·73	3·68	0·44	2·75	..	..	..	..
Banswara dist.	38·82	5·0	21·58	0·15	6·7	..	..	..	..
Kamiji mines, Banswara dist.	21·74	14·23	3·46	0·58	1·89	18·72	..	..	..
Itala mines, Rajasthan	33	5·8	34·08	0·18	5·1	..	..	0·055	..
Chorbaoli Forests, Nagpur	35·10	10·85	14·24	0·43	8·13	..	..	..	..

3.07 **Conclusions**

(1) Indian manganese ores are fairly hard, lumpy and easily reduciable; these characteristics are favourable for smelting to produce ferro-manganese.

(2) Indian ores have, however, low Mn : Fe ratio generally of 6 : 1 as compared to Caucasian ore ratio of 50 : 1, Ghana 10 : 1 and Brazil 10 : 1. This is below specifications for the manufacture of ferro-manganese, which requires high Mn-Fe ratio.

(3) High phosphorus ores especially of Andhra Pradesh and Panch Mahals are also not very suitable for ferro manganese industry.

(4) In view of these characteristics, blending of ores of various grades is a necessity.

3.08 Recommendations

(1) There is ample scope for blending ores of different types to produce standard mixtures with acceptable percentages of various constituents, particularly manganese, iron and phosphorous. Blending operations, if they are to be productive of optimum results, would require careful control of the grade of ingredients *i.e.* different types of ores which go into the final mixture. This will be greatly facilitated if the entire operation is carried out by or under the direction of an expert agency which has control of or access to the different grades of ores.

(2) Blending of ores should be done at a few selected points having regard to the extent and quality of production from particular manganese producing areas. Variation in composition of the ores is no bar to blending. In fact such variations within a certain range provide scope for ingenuity of the "blender". It is possible to mix ores for production of a few standard grades acceptable to the foreign buyers. Some of the well known grades are 'Oriental' and 'Standard' mixture of Manganese Ore (India) Ltd. and Central Province Manganese Ore Company Ltd., 'Sandur A' and 'Sandur B' of M/s. Sandur Manganese and Iron Ore (P) Limited.

(3) There is great scope for beneficiation of ores. This aspect deserves more attention than it has received so far. Details of the problems of beneficiation have been discussed under the Chapter 'Beneficiation'.

(4) There is need for specialised research to achieve reduction in phosphorous content of ores. The Indian Bureau of Mines should be asked to pay special attention to this matter and undertake further investigation. The National Metallurgical Laboratory has recently commissioned an integrated pilot plant to carry out studies to evolve suitable processes for the beneficiation of low grade manganese ore at a capital cost of Rs. 35·00 lakhs. The N.M.L. could be requested to conduct studies into the methods of reducing phosphorus also.

BIBLIOGRAPHY

1. Physical and Chemical Characteristics of Manganese Ore by A. M. Hussain, Eastern Metals Review, Independence Number, 1961.
2. Materials Survey 'Manganese', United States, Bureau of Mines, October, 1952.
3. Metallurgy of the Rarer Metals-Manganese, 1956.
4. Report of the beneficiation of low grade manganese ore Committee, 1957.
5. Beneficiation of low grade manganese ores of India by P. I. A. Narayanan and N. N. Subrahmanyan, 1959.

CHAPTER IV

USES AND SPECIFICATIONS

4.00 Broadly speaking, manganese ore is an essential raw material for metallurgical and chemical industries and is also used in the dry cell battery manufactures. It is estimated that about 96 per cent. of the world's total production of manganese ore is taken up by the metallurgical industries, the remaining 4 per cent being used principally in dry batteries and in the chemical and paint industries.

4.01 Metallurgical uses and specifications

Manganese ore added to the blast furnace introduces manganese into the pig iron and favours desulphurisation. There is no fixed specification of the manganese ore as a blast furnace charge. In India ore of less than 30 per cent manganese is considered appropriate for the purpose.

Manganese in the form of ferro-manganese is chiefly used for deoxidation during steel making. It gives requisite cleanliness and strength to steel. In fact it has been said that 'steel is not steel without manganese'.

Manganese is usually added to molten steel as standard grade ferro-manganese. Several other grades of ferro-manganese, e.g, spiegeleisen, silico-spiegel, silico-manganese and a few others are also employed. The composition of different grades of ferro-manganese is given below :

	Mn	C	Si	P	S
			(Percentage)		
1. Standard-grade or high carbon.	78-82	6-8	1·0	0·3	0·05
2. Medium carbon .	80-85	1-5	1·5-2·5	..	..
3. Low-carbon . .	80-85	0·1-0·75	1·0-7·0	..	..
4. Low-phosphorus .	78-82	5·5-6·5	5·0	0·1	..
5. Low iron . . .	85-90	7·0	3·0	..	..

For the production of standard grades ferro-manganese ores of suitable quality are required. The ore should have high manganese content. The ratio of iron : manganese should be 1 : 9 or 10 to yield ferro-manganese of 80 per cent grade. Slag forming constituents in the ore should be within limits. Sulphur and phosphorus are undesirable in the ore.

The table below gives the specifications of manganese ores purchased by three important steel manufacturers in the U.S.A. who are the chief buyers of manganese in the world market :—

	United States Steel Co.	Sloss Sheffield Steel & Iron Co.	Bethelhem Steel Co.
Chemical Comp :			
Mn. . . .	48% (Aver)	Mn. 48% (min)	Mn 40% (min)
Fe . . .	6% (Aver)	Fe. 6% (max)	Fe 14% (max)
$SiO_2+Al_2O_3$ . . .	11% (Max)	SiO_2 6% (max)	SiO_2 + Al_2O_3. 15% (Max)
P . . .	0·12% (max)	P 0·12% (max)	P 0·18% (max)
Zn, Sn, Pb and Cu. . .	Trace	Pb, Zn, Trace As.	Cu, Pb, Zn 0·5% (max) Mn : Fe ratio 3·5 : 1 (min).
For blending :			
Mn.	40% (Min)	Mn 45%	*Note.*— Purchases to be restricted so as to maintain a stockpile of the following minimum average composition : Mn. 48% (min) Fe. 6% (max) SiO_2 + Al_2O_3 12% (max) P 0·12% (max) Cu, Pb, Zn 0·1% (max)
Overall—Mn : Fe ratio	7·5 : 1		

The size of lump ore should not exceed maximum limit of 5 inches. The proportion of "smalls" and fines of less than 20 mesh size should be limited. In the case of dense granular ore, proportion of fines of less than 20 mesh screen should be restricted to 7 per cent. In more porous ores, fines of less than 14 mesh screen should be within 10 per cent limit. Proportion of fines of less than 20 mesh screen should not exceed 5 per cent.

4.02 The following table lists the characteristics of various ores purchased by the Steel companies in United States from various countries.

Country	United States Steel Company	Sloss Sheffield Steel & Iron Co.	Bethelhem Steel Co.
Russian . . .	..	..	Mn 50 % Fe 0·75 % SiO_2 10 % P 0·175% Al_2O_3 2%
Indian	Mn 49% Fe 8% Al_2O_3, Fe_2O_3 } 10%	Mn 42·26—50·19% Fe 4·09—12·94% SiO_2 1·67—10·73% Al_2O_3 1·74— 5·06% P 0·072—0·224%	Mn 50% Fe 6·5 % SiO_2 7·85 % Al_2O_3 1·75 % P 0·12 %
South Africa (1st grade) . .	Mn 40—50% Fe 10—15% SiO_2 2·5—3·0%		Mn 49·0 % Fe 9·0 % SiO_2 3·5 % Al_2O_3 3·75 % P 0·05 %
Ghana . . .			Mn 46·0 % Fe 5·0 % SiO_2 5·0 % Al_2O_3 4·0 % P 0·12 %
Brazilian	Mn 45·0% Fe. 4·5% SiO_2, Al_2O_3 } 12·0%		Mn 45·0 % Fe 5·0 % SiO_2, Al_2O_3 } 7·5 % P 0·1%
		Mexican	*Chilean*
		Mn 45·02—47·59% Fe 2·04— 2·39% SiO_2 8·01—12·93% Al_2O_3 1·10— 2·60% P 0·028—0·047%	Mn 48·5 % Fe 0·75 % SiO_2 11·0 % Al_2O_3 2·0 % P 0·02 %
		Cuban	*Nodular Ore, Montana, U.S.A.*
		Mn 42·72—45·98 % Fe 1·2— 2·26 % SiO_2 5·77— 7·39 % Al_2O_3 1·6— 2·09 % P 0·043—0·067%	Mn 60·0 % Fe 3·0 % SiO_2 8·0 % Al_2O_3 0·75 % P 0·05 %

4.03 Indian ores exported to U.S.A. contain about an average of 49 per cent manganese, 8 percent Fe, less than 10 per cent combined SiO_2 and Al_2O_3. Other impurities are low. Physically the ore is suitable for ferro-manganese production, provided 85% of the charge is over ½" size and not more than 5% is below 20 mesh size. Brazilian and South African ores have different chemical and physical properties and contain 65 to 75 per cent over ½ inch size. The U.S.A. Steel makers prefer to blend Indian ores with South African, Brazilian and nodular manganese ores of United States of America for making ferro-manganese of their specifications.

4.04 The following table gives the chemical composition of manganese ores used by the ferro-manganese producers in India.

1. *Mysore Iron & Steel Works*

Mn %	42—44

2. *Cambatta Ferro-manganese (P) Ltd.*

Mn %	46—48 (min)
Fe %	8 (max)
Al_2O_3 + SiO_2 %	14 (max)
P %	0·15

3. *Ferro-alloys Corporation Ltd.*

Mn %	46—48
Fe %	7
Al_2O_3 %	
SiO_2 %	
P %	0·15

4. *Joda Ferro-alloys (P) Ltd.*

	I	II
Mn %	47—48	40—42
Fe %	9—10	10—11
Al_2O_3 %	3—6	4—6
SiO_2 %	4—6	6—12
P %	0·1	0·075

5. *M/s. Jeypore Sugar Co.*

Mn %	46—48
Fe %	8
Al_2O_3 + SiO_2 %	9
P %	0·15

6. *M/s. Khandelwal Ferro-alloys Ltd.*

Mn %	46—50
Fe %	8—10
Al_2O_3+SiO_2 %	12
P %	0·07

With the expansion of steel industry, a large sizeable internal market will be created for ferro-manganese. It may then be possible to use medium grade ore for the production of ferro-manganese to meet a part of internal requirements.

4.05 Manganese Metal

Investigations for new uses of pure manganese in both ferrous and non-ferrous industries have been made. There are three known processes for the commercial production of pure manganese metal, *viz.* silico-thermic reduction, alumino-thermic reduction and electrolytic process. The last is the best known technique for it helps to produce the purest metal at the most economic cost. As manganese metal is completely free from impurities, like phosphorus, carbon etc., its use is considered highly desirable in the production of special steels. A process for utilising manganese metal in the commercial production of stainless steel has also been perfected. This is of special interest in view of the lack of nickel deposits in India. Low grade manganese ores, high in silica and phosphorus or iron can be utilised directly to produce electrolytic manganese. The National Metallurgical Laboratory has developed the process of electrolytic production of manganese metal which is operated on a pilot plant scale with an output of 100 lbs. of metal per day. With the increased production of special steel, demand for manganese metal is likely to increase. A few licences have already been given to some parties for the production of manganese metal. The possibilities of an export market for manganese metal need to be explored.

4.06 Dry Battery Manufacture

High grade pyrolusite rich in dioxide content is used as a depolariser. Recent investigations have shown that the suitability of ore for dry battery manufacture depends on the form in which MnO_2 is present, the gamma and delta forms being more desirable. Natural, synthetic and chemically treated natural ores are used in the manufacture of dry battery.

The ore should be free from copper, nickel, cobalt, arsenic, lead and antimony etc. which are electronegative to zinc. Iron content should be as low as possible. These impurities, in insoluble form, owing to their poor electrical conductivity values, increase the internal resistance of the cell. In soluble form they are more deletrious as the solutions diffuse into the zinc container and corrode it. Copper is particularly harmful in this respect. Ferric iron, owing to its relative insolubility, is much less objectionable than ferrous iron, and hence pyrolusite containing 3-4 per cent ferric oxide may be employed. Metallic iron is very deletrious and is therefore magnetically removed. A certain degree of porosity is also desirable.

The battery-grade ore, accordingly to the specifications of the Signal Corps of the united States Army should have the following composition:

	Natural ores	Synthetic material
Available O_3 as percent MnO_2 . . .	75% (min.)	85% (min.)
Total Mn. as percent, Mn.	48% (min.)	58% (min.)
Absorbed moisture as percent H_2O . .	5% (max.)	3% (max.)
Iron as percent, Fe (Sol. in HCl) . . .	3% (max.)	0·2% (max.)
Silicon as percent, SiO_2	5% (max.)	0·5% (max.)
Metallic impurities (Cu, Cd, Ni, Pb, Sb, etc.) .	0·2% (max.)	0·1% (max.)
PH	4·0—8·5	4·0—8·0

4.07 In India battery grade ore is mostly imported. Recently, a cômmittee has gone into the details of indigenous production, *vis-a-vis* internal requirements of dioxide ore and submitted its report to the Government. Generally, it has been held that indigenous production does not conform to proper allotropic form for battery manufacture. It has been stated that the quality of the indigenous ore is suitable only for radio batteries where a low current drain is necessary. Where, however, high current drain is desirable, as for flash light and torch batteries, Indian ores have not been found suitable.

The Dioxide Committee mentioned above has estimated requirements of manganese dioxide at about 15,000 tons during the next five years period, the major consumer being the battery industry. The Committee is of the view that at present producers are blending dioxide ore with low grade manganese ore to make the ore marketable. It has been recommended that such blending should not be allowed. Further, higher freight rates have been recommended for levy on ores analysing more than 85% manganese dioxide only. But ores with lower percentage of MnO_2, the normal freight levied on other manganese ore has been suggested for a period of three years in the first instance. Similarly, royalty of Rs. 10/- per tonne is considered adequate for dioxide ore. The recommendation of the Tariff Commission for installation of electrolytical dioxide plant has also been reiterated by the Committee.

4.08 **Chemical Industry**

Manganese-dioxide ore is widely used in chemical industry for the manufacture of iodine and organic chemicals. Potassium and sodium permanganate find wide use in industrial chemistry and in medicine. The sulphate of manganese is used in the manufacture of other salts and in calico printing. Chloride of manganese is used as a bronze dye in the cotton textiles.

4.09 Manganese salts are widely used in photography, the leather trade, the match industry, in medicine, as a flux and as a floating agent in the ore treatment, etc. Manganese ore also finds a use in agriculture generally in the form of sulphate and acetate salts.

4.10 Manganese dioxide, in the form of manganese earths and ambers, is used as a pigment. Certain manganese compounds of various colours are also marketed as pigments. Manganese oxides and salts are used as driers for oils, varnishes and paints. Manganese ore of hige purity is required for these purposes.

4.11 In India manganese ore is consumed almost entirely in the steel industry in the form of ferro-manganese and also as a direct feed for the blast furnace. For the direct feed, low grade ore (30%Mn.) is used. The following is the approximate break up of consumption of manganese ore by the main user industries.

Ferro-manganese	...	55%
Blast furnace	...	43%
Battery	...	2%
Chemical etc.	...	Negligible

BIBLIOGRAPHY

1. Metallurgy of the Rarer Metals-Manganese-Sully.
2. Bulletins of the Geological Survey of India Series A—Economic Geology No. 20—Manganese by J. A. Dunn.
3. Hand Book of Industrial Minerals and Mineral Consumers in India by Shri H. R. Dewan, Director, Indian Bureau of Mines, July, 1962.
4. Report of the Manganese Dioxide Committee, 1964.

CHAPTER V

BENEFICIATION AND BLENDING

5.00 In almost all the manganese ore producing countries, the lode material' as taken out of the mine is not sold to overseas buyers or put to indigenous use until after it has been subjected to beneficiation treatment. The upgraded material may be either in the form of 'coarse concentrates' or 'fines' depending upon the nature of the ores and the technique employed. Crushing, screening, hand sorting, jigging and heavy media separation of ores produce lump concentrates. These methods are relatively cheaper but are applicable only to 'simple ores'. The 'complex ores' would need finer crushing, tabling, flotation and reduction roasting etc. Further, 'fines' have to be nodulised before use, which makes beneficiation of such ores a costly proposition.

It may also be mentioned that beneficiation methods do not always produce concentrates directly suitable for furnace load. Blending is common in manganese ore industry. Almost all consumers of manganese have their own arrangements for blending ores drawn from various sources.

In India it is generally seen that for every ton of high grade ore produced from the mines two tons of ores having low manganese content are also produced which need to be beneficiated. These low grade ores are generally of a complex nature from the point of view of beneficiation.

In view of the fact that overseas markets exist for ores with as low as 28-30% manganese content, and beneficiation necessarily entails reduction both by weight and volume of the original material in the process, it is important that economics of beneficiation are carefully worked out before such a process is adopted. In the case of complex ores pilot Plant studies should first be carried out. Crushing, screening and washing of lump ores with the object of upgrading the manganese content, could, however, be advocated without reservation of the necessity of any prior detailed studies. Heavy media separation techniques should be applied to ores susceptible to this method.

Problems connected with beneficiation and blending of ores in India have been fully discussed in this Chapter and suitable suggestions have been given.

A brief resume of methods adopted in important manganese ore producing countries of the world follows:

5.01 Union of Soviet Socialist Republics

In Russia most of the ore taken out of the mine is soft and low grade and requires beneficiation before marketing. A study of the nature of occurrence and characteristics of ores given in Chapters II and III would

show teat Russian ores require crushing, washing and agglomeration. At times flotation, Jigging and tabling is also employed. The Seventh Five Year Plan of the Russian Government calls for doubling the production from Nikopol field by 1965 to about 10 million tons per annum. The Chkalovakaya Mining and Processing combine in this field will be the largest manganese undertaking in U. S. S. R. Among other things, it comprises a seven storey concentrator and a manganese agglomeration plant. In Chaiture field also, it is planned to double the production. A plant for processing manganese waste is being constructed and is expected to produce large tonnages of metallic manganese from dumps at Chaiture and Nikopol.

5.02 **Brazil**

Amapa :—The preparation of ore consists of crushing, screening and washing. The ore is transported in 25 tons trucks to a primary crusher located at a distance of about 2 miles from the mines where it is dumped into a 40 ton hopper and delivered by a pan feeder to a 48″ × 65″ Black-type jaw crusher powered by a 300 h.p. motor through V-belt drive. With a 6 1/2 inch setting at the open side, the crusher has a capacity of 450 tons per hour. A belt conveyor carries the ore to a secondary crushing plant, where it is first delivered to the coarse screen, a 5 × 12 ft. double decked vibrating screen with 6″ sq. openings on the top deck and 4″ sq. openings in the bottom deck. High pressure water spray removes clay and rubble from the ore on the screens. Oversized ore (above 6″) is fed by chute from the screen into the secondary crusher, a 4 ft. gyratory of 135 tons per hour capacity powered by a 200 h.p. motor. This Crusher is set at 4 1/4 to 5″. This discharge from the secondary crusher is either delivered by a 30″ belt conveyor directly to either of two 550 ton coarse ore loading bins, or it may be diverted and delivered by another belt conveyor to a 9 × 18 ft. revolving scrubber. Remaining material −6″, +4″ may like-wise go to the ore bins or the scrubber. In the revolving scrubber, the ore is given a thorough wash to remove all remaining clay and dirt.

The discharge from the scrubber passes over a dewatering screen with 3/16″ round openings and then to the fine screen, a 6′ × 14′ double-deck vibrating water-sprayed screen with 1 1/2″ sq. holes on the upper deck and a mesh bottom deck. This double-deck screen is used only for the purpose of increasing the screening efficiency and not for separation as the material over both decks is discharged to the same 30″ belt conveyor and carried to the coarse ore bin. The discharge through the bottom deck, combined with the underflow from the dewatering screen, is treated in an 8 × 31 1/2 ft. rake classifier. Recovery is 4/5th plus 1/4″ size and 1/5th − 1/4″ size. These two sizes are separately loaded in bins and stacked on quay for blending at the time of shipments. The difference in manganese content of the ore of sizes between + 1/4″ and − 1/4″ is about 4%. The average analysis of the mixed ore is Mn 49%, Fe 4-5%, SiO_2 2-3%, P 0. 09%. Moisture not exceeding 5%.

Lafaite. All ore either mined or recovered from the dumps is crushed, screened and washed before being transported. A picking

gangue is employed for removal of extraneous materials from the moving conveyor belt. A regular assay record is maintained of the Mn. content of the ore recovered from the spoil dumps before and after washing. About 10% Mn. content is increased at a low cost.

5.03 **Gabon**

The ore after it is taken out of the mine is crushed, washed and screened. Material under ¼" is rejected as tailing. These fines constitute approximately 30 to 40 per cent of the water feed. The marketable product plus 1/4" has an analysis of 50 to 52% Mn., 3 to 4 per cent ferric-oxide, 2 to 3.5 per cent SiO_2, 6-7% Alumina and 0.10 to 0.13 per cent phosphorus.

5.04 **Other Countries**

The Nsuta ores in Ghana are washed to remove clay impurities. At Buttee, U. S. A. it has been found practicable to improve the low grade carbonate ores by flotation, after which the low phosphorus concentrate is sintered, the product containing 60 to 62% Mn and 7 per cent SiO_2 at a cost of $1·00 to $1.50 per ton. On Guyuna iron ore range, Minnesota, U. S. A. some of the manganiferrous iron ore may be brought upto 17% Mn suitable for the manufacture of spiegeleisen by the use of tables and flotation. It has also been found practicable to improve the grade of Cuban manganese ores by flotation and sintering.

5.05 **India**

There is not much activity at present in the field of large-scale mineral beneficiation in India. Growing realisation of this aspect, however, is noticeable and some firms have taken active interest in setting up beneficiation plants. Mention may be made of the heavy media separation plant, at Dongri-Buzurg mine of C.P.M.O. Co. Ltd. set up in 1954 at a cost of Rs. 25.00 lakhs. Besides this M/s Sreeram Durga Prasad have set up a beneficiation plant at considerable cost at their Garividi Mines in Srikakulam district of Andhra Pradesh. This plant, however, is facing certain difficulties in the matter of achieving the reduction of phosphorus content of the ores.

Some of the beneficiation practices followed in India at present are described below. These techniques are calculated to produce only coarse ores. No attempt has so far been made to adopt methods which would treat complex ores as the concentrates produced in these processes are in the form of fines which have to be briquetted before use. Production of fine powder and its briquetting is in experimental stage at some places such as Dandeli (Mysore) and Garividi (Andhra Pradesh).

The techniques followed in India comprise hand sorting and picking, jigging (mechanical and manual), washing and heavy media separation. There is a wide variation in the recovery percentage of manganese ore from area to area. On an average, concentration ratio is 10 : 1 to 20 : 1.

The cost of concentration and upgrading treatments depending upon the method adopted are as follows:

1. Breaking and sorting	Rs. 5 per ton of concentrates.
2. Jigging	Rs. 5 per ton of concentrates.
3. Heavy media	Rs. 7 per ton of concentrates.
4. Washing	Rs. 2·50 per ton of concentrates.

A brief description of the various techniques is given below :—

1. *Hand sorting and hand picking.*—This is the most common method practised in the country both at the mines and rail sidings, for ensuring so far as possible, despatch of clean ore.

2. *Hand Jigging.*—The method is based on the principle of specific gravity. Manganese minerals are separated from gangue material as they are much heavier than the gangues. Joplin jigs are extensively used throughout the country. A joplin jig together with an iron tub costs Rs. 200 to Rs. 250.

3. *Mechanical washing and jigging.*—Hancock jig is used at Shivrajpur and mechanical washers at North Tirodi mines and Barajamda sector. Hand operated and mechanically operated rumblers are commonly used in North Kanara Sector especially to remove the hard lateritic coating on the ore.

4. *Heavy media separation plant.*—There is one Heavy Media Separation Plant at Dongri Buzurg mines of M/s C.P.M.O. Ltd. in Madhya Pradesh. The plant has a capacity of 70 tons ore treatment per hour. It was set up in the year 1954 at a cost of Rs. 25 lakhs. In principle the process is very simple consisting of separation of light from dense material in a medium of ferro-silicon in water with higher density, which can be maintained upto 3·4 times that of water itself. This is accomplished in the Wemco Drum Separator which is the heart of the process. The heavy pieces of ore sink in the medium and are drawn off separately from the lighter pieces of useless rocks.

The material from the dumps is fed to a mobile screen unit containing a grizzly set at 5″ and an Allis Chalmers double deck screen (6′ × 16′). The top screen has an opening of 3/4″ and the bottom one of 1/8″. The—5″ plus 1/8″ fraction is carried in tubs to a 1000 ton ore bin which feeds the Heavy Media Separation Plant. The grizzly oversize (plus 5″) passes on to a 24″ × 15″ jaw crusher and the crushed product is carried to the main ore bin by a bucket elevator.

The ore is conveyed by an apron feeder to a 30″ wide conveyor belt and from there, it is fed to an Allis Chalmer 6′ × 16′ double deck screen (top screen 1/8″ bottom screen 1/16″) where it is wetted thoroughly. The fine material (1/16″) flows to the reject tank. All the —5″ plus 1/8″ ore is fed to a 8′ × 4′ WEMCO drum separator which contains a suspension of ferro-silicon medium.

The specific gravity of the medium is maintained at about 3·0. The ferro-silicon used as a medium is a —65 mesh material containing about 15% silicon. The drum separator is specially designed to suit the variable feed size (5″ to 1/8″). It contains sinks and float launders and scoops for carrying the sink portion to the sink launder. The drum is rotated slowly (2 r.p.m.). The sink (concentrate) and the float (gangue) materials are carried on their two respective 6′×16′ single deckscreens, used for the separation of medium. The concentrate is transferred by a 48″ wide picking belt conveyor to a 100 ton concentrate bin while the tailings are transported by an 18″ wide belt conveyor to the reject bin. The media is divided into two sections. The medium from the first portion of the screens is concentrated and is suitable for direct use. This is pumped back by a 6″ sand pump to the drum separator. The medium from the second portion is dilute as it contains washings from the concentrate and tailings. The dilute medium is transferred to a 8′×8′ settling cone. The sludge from the cone is pumped by means of 4″ Wilfley sand pump to a 48″ Rapid magnetic separator (capacity 50 tons per hour of magnetic material). The concentrate (Fesi) passes to a 36″ Akin's densifier for the adjustment of density of the medium, after which it is transferred to the drum separator. Tailings from the magnetic separator are passed to another magnetic separator of the same size to recover the remaining ferro-silicon. A size 20 Wilfley table is also provided to remove the magnetic manganese from ferro-silicon, if necessary. Almost all the ferro-silicon is thus recovered in the process. However, there is a small loss of the medium material which is inevitable (about one pound per ton of concentrate). Every care is taken to recover water from thickner settling tanks etc.

The electric power necessary for the plant is procured from the Khaperkheda Power House at 11,000 volts. The company has a sub-station at plant site to supply 440 volts power to the plant. The power consumption of the Heavy Media Separation Plant is estimated at about 250 H.P. The phosphorus content is obviously on the high side. The plant had its teething trouble. The main difficulty was about the fines which are magnetic. After lot of experimentation, modifications have been made in the plant specially in the double deck screen so as to take out the fines prior to the ore passing through the dump separator. These fines —1/8″ plus 1/16″ are treated separately in Hartz jigs. The plant can treat about 600 to 700 tons of ore per day. The manganese content of the feed is 40 to 42% and the beneficiated material contains 50 to 51% Mn. The rejects contain 20 to 25% Mn. out of which 1/4th are fines.

5·06 The various beneficiation techniques adopted in India have been described in the above paragraphs.

5·07 A number of important pilot plant and laboratory studies on low grade manganese ores of various regions were conducted by National Metallurgical Laboratory, Indian Bureau of Mines and Geological Survey of India. A brief description of these studies and test is given at Annexure I to this Chapter.

5·08 Conclusions

(1) Almost all important manganese ore producing countries of the world such as Brazil, Gabon, Ghana etc., undertake beneficiation processes which do not result in the production of concentrate fines. Coarse concentrates do not require agglomeration.

(2) In Brazil, the preparation of ore consists of crushing, screening, washing and dewatering. Almost a similar process is followed in Gabon. Ores are washed to remove clay impurities in Ghana.

(3) Russian ores require crushing, washing and agglomeration of fine concentrates. At times floatation, Jigging and tabling is also employed.

(4) In India main operations are breaking and hand sorting. Jigging and washing are employed on a limited scale. There is only one heavy media separation plant in the country.

(5) From the point of view of beneficiation, Indian ores have broadly been divided into four groups *i.e.* simple, ferruginous, garnetiferrous and complex. From the work carried out by the National Metallurgical Laboratory and the Indian Bureau of Mines, it is seen that only a small proportion of the manganese ores in India can be classified as simple ores requiring comparatively simple treatment like gravity concentration etc. There is a preponderance of ferruginous and garnetiferrous ores and these require more elaborate and costly beneficiation plants. From the data of research work, however, it can be seen that most of the ores are amenable to beneficiation and the concentrates obtained are generally suitable for ferro-manganese production. Concentrates of the complex ores would need blending with other suitable concentrates to meet the specifications.

5·09 Recommendations

(1) The problem of beneficiation in India has to be viewed in two ways (a) production of beneficiated coarse concentrates (b) production of concentrate fines and their agglomeration.

(2) The former should receive immediate attention. The lump ores could be upgraded to a considerable extent by crushing, screening, washing and jigging. Such ores could be carefully blended with ores, from other regions to produce clean standard grade ore required by the foreign buyers. This may not be feasible in the present state of affairs of the industry where the bulk of production is accounted for by a very large number of producers and exports are similarly handled by numerous exporters. In the circumstances, beneficiation of ores and expert blending of different ores could be successfully undertaken only by a cooperative organisation of producers and exporters of manganese ore or by any other centralised agency which could command resources, organisation and expertise for handling ores from a large number of mines and adopting beneficiation techniques without affecting the economics of export. It should be possible to set up in North Kanara,

Orissa, Madhya Pradesh and Maharashtra a few relatively simple beneficiation units employing crushing, screening, jigging and washing techniques.

(3) Heavy media separation holds considerable promise. It can serve as a pre-concentration unit to reject waste rock from the run of mine ore and deliver an enriched sink for further concentration. It thus allows for indiscriminate mining without any laborious selection. By discarding the waste rock at an early stage, the mill gets an enriched feed and, for the same throughout, a larger production is obtained. This process yields a finished concentrate and a middling for further treatment. The finished concentrates may meet the size requirements for some ores without, any sintering or agglomeration process. The process brings about a greater reduction in the amount of material passing through the various crushing, grinding and concentration plants. It is applicable only to those areas in which a fair amount of mineral is liberated at coarse size. The minerals should also be separable at specific gravity less than 3·3. Manganese minerals of India generally possess a specific gravity of about 4 and therefore can be concentrated by heavy media separation from quartzitic or schistose rocks. The Committee recommends installation of a few more heavy media separation plants in Madhya Pradesh and Maharashtra region.

(4) It may be possible to blend North Kanara ores with Panch mahal ores, Shivrajpur and Orissa ores with Srikakulam ores. Due to wide variations in the composition of ores from one mine to the other, it may also be possible to blend ore locally in accordance with a carefully drawn up detailed scheme.

(5) As it has already been stated above, different categories of manganese ores of India are amenable to beneficiation. The beneficiated ore, *i.e.* concentrate, is in the form of powder which would have to be agglomerated before use. Concentrates of complex ores would need careful blending. The Committee recommends the beneficiation of such ores and its use in the ferro-manganese plants after suitable agglomeration in the country. This would release lumpy ores for exports. The prospects of exporting agglomerated or nodulised concentrates could also be explored.

(6) It is seen that earlier in 1957 a committee had been constituted by the late Ministry of Natural Resources and Scientific Research to examine the problems of beneficiation of low grade manganese ore particularly those derived from Karwar, Madhya Pradesh and Rajasthan. The Committee had recommended *inter alia* that pilot plants should be installed by the Indian Bureau of Mines and the National Metallurgical Laboratory at Nagpur and Jamshedpur respectively to carry out pilots plant studies on low grade manganese ore. It was suggested that the results of these studies should form the basis for designing of special beneficiation plant. The Committee note that, although a number of years have elapsed since the recommendation of the earlier committee was formulated, no significant progress seems to have been made in this direction.

It is recommended that pilot plant studies on low grade manganese ores from various regions in India should be completed by the Indian Bureau of Mines and the National Metallurgical Laboratory on top priority basis and designs of beneficiation plants should be worked out by them. The new agency proposed should take care of the matters connected with installation and working of these plants.

(7) The Committee recommends that concessional royalty rate should be charged for beneficiated ore in order to provide an incentive for adopting beneficiation techniques to upgrade low quality ore. This could be fixed at 50% of the rate of royalty applicable to the grade of unbeneficiated ore.

(8) The other incentive in the form of special railway freight rate for ore meant for beneficiation is also to be recommended. This is necessary because for one ton of beneficiated ore about 3 tons of low grade ore have to be transported. This may be fixed at 50% of the prevailing freight rate for exports.

(9) In order to ensure a regular supply of the feed of low grade ore for the beneficiation plants, it will be desirable to attach suitable captive sources of supply to such plants. In case of large efficient units, preference in the matter of grant of leases of additional areas should also be accorded.

BIBLIOGRAPHY

(a) Material Survey 'Manganese', United States Department of Interior.

(b) United States, Mineral Year Book—1962.

(c) Beneficiation of low grade manganese ores of India by P. I. A. Narayanan and N. N. Subramanyan, 1959.

(d) Report of the Beneficiation of low grade ore Committee, 1957.

(e) Bulletin of the Geological Survey of India, Series—A—Economic Geology No. 20 Manganese by J. A. Dunn.

(f) Know-How Conquers Jungle—A Brazilian Publication.

(g) Brazilian Business—Brazilian Publication.

(h) Field Reports of the Committee on Manganese ore.

ANNEXURE I

Pilot Plant Tests and Laboratory Studies Conducted by National Metallurgical Laboratory, Indian Bureau of Mines and Geological Survey of India on Low Grade Manganese Ores of Various Regions

(*i*) *Semi pilot plant studies on the beneficiation of ferruginous manganese ore from Joda West Mines of Tata Iron and Steel Company Limited:*

A process based on low temperature magnetising gaseous reduction has been developed by the National Metallurgical Laboratory which produces high grade manganese concentrates from ferruginous low grade manganese ores. This process excludes external heat for the reduction process and yields a friable product which can be very easily crushed and ground for the subsequent magnetic separation.

A concentrate of grade about 52% Mn with a Mn : Fe ratio of 7: 1 was obtained from a low grade ore from the mines of Tata Iron and Steel Company Limited in Keonjhar district, Orissa, assaying 27·2% Mn, 24.2% Fe, 7.53% SiO_2, 7.43% Al_2O_3 and 0.09% P with a manganese recovery of 62%. Three tons of low grade ores were required to produce a ton of manganese concentrate suitable for making standard grade ferromanganese.

The following is the cost analysis of beneficiation worked out by the National Metallurgical Laboratory :

	Rs. per ton of raw ore.	Rs. per ton concentrate.
Crushing	0.40	
Washing & Screening	0.50	
Reduction	4.24	
Secondary crushing & grinding.	0.80	
Magnetic separation	0.60	
	6.54	19.62
Drying & briquetting		7·50
	Rs.	27.12

The cost of the concentrate is estimated at about Rs. 85.00 per ton inclusive of cost of mining, upgrading, treatment, briquetting and depreciation on the basis of an estimated capital outlay of Rs. 90 lakhs required for a plant to upgrade 600 tons of low grade ore per day. A Plant of this size can produce concentrate to feed the plant with a production capacity of 36,000 tons of standard grade ferro-manganese per year. The following metallurgical advantages in employing this concentrate in a reduced state for ferromanganese production is advocated :

(a) The requisite ratio of manganese to iron is consistently assured making it possible to get a high grade ferromanganese.

(b) The contents of slag forming constituents are kept within the desired specifications and this should decrease the loss of manganese in the slag.

(c) As manganese is present mostly in the manganous state (MnO) this should decrease the amount of coke.

(d) The utilisation of low grade manganese ores will prolong the life of the mines and of the ferro-manganese plant at Joda.

(*ii*) *Laboratory study on sample from Kachidhana Mines, Madhya pradesh conducted by the National Metallurgical Laboratory and Indian Bureau of Mines.*

A sample of low grade manganese ore from Kachidhana mines, Madhya Pradesh consisting of braunite, psilomelane, pyrolusite, garnet, jaspery silica, iron stained quartz, some incrustations of calcite and some amount of schistose material was subjected to ore dressing treatment by gravity concentration and flotation methods.

The sample as received assayed 41.6% Mn, 14.6% SiO_2, 8.46% Fe and 0.21% P.

Jigging of —4 plus 10 and —10 plus 28 mesh fractions produced a combined concentrate assaying 51.18% Mn, 6.45% SiO_2, 6.37% Fe and 0.19% P, with manganese recovery of 60.1%.

The —28 mesh fractions obtained after the removal of the jig feed was mixed with the jig tailings crushed to —28 mesh. The mix when tabled yielded a product (concentrate plus middling) assaying 43.5% Mn, 13.4% SiO_2, 7.72% Fe, and 0.21% P, with manganese recovery of 22.7% in terms of the original sample. The presence of garnet in the table concentrates rendered its grade poorer than that of jig concentrates.

The jig and table concentrates and table middling when mixed may be expected to yield product assaying 48.9% Mn, 8.64% SiO_2, 6.28% Fe and 0.19% P with an overall recovery of 82.58% Mn. On ignition a sample of this product assayed 51.56% Mn, 8.69% SiO_2 and 9.5% Fe.

A product assaying 47.66 % Mn, 8.44% SiO_2, 7.8% Fe, 0.19% P with a manganese recovery of 69.3% was obtained by straight tabling the ore ground to —28 mesh. On ignition a sample of this product assayed 51.12% Mn, 9.51% SiO_2 and 9.6% Fe.

Flotation of the original sample using sodium silicate as depressant and American Cyanamid Regent 708 as Collector produced Concentrates assaying 47.7% Mn, 9.16% SiO_2, 9.00% Fe and 0.186% P with a manganese recovery of 74. 23%.

Flotation of straight table tailings produced a concentrate assaying 46.62% Mn, 7.38% SiO_2 and 7.18% Fe with a recovery of 60 per cent of the manganese in the tailings.

Experimental results so far obtained indicate that in this particular instance jigging followed by flotation of the tailings would result in a good recovery of the beneficiated material.

Economics of the beneficiation treatment will be assessed on the basis of pilot plant scale tests at the laboratory.

(*iii*) *Laboratory study on sample from Tirodi Mines, Madhya Pradesh conducted by National Metallurgical Laboratory and Indian Bureau of Mines :*

The manganese minerals in the ore are braunite, and psilomelane with a little pyrolusite and the principal gangue minerals present are quartz and garnet.

The sample assayed 27.39 per cent Mn, 33.4 per cent SiO_2, 7.47 per cent Fe and 0.36 per cent P.

Jigging followed by magnetic separation recovered 72.0 per cent manganese in a concentrate of grade 38.78% Mn, 16.28% SiO_2, 12.32% Fe and 0.37% P. The combined concentrates on heating assayed 41.40% Mn, 17.38% SiO_2, 12.15% Fe and 0.39% P. The high silica in the concentrate is due partly to braunite (contains 10% SiO_2 when pure) and partly to the presence of garnet which has nearly the same specific gravity as the manganese minerals and partly to the inter-locked siliceous gangue.

Straight magnetic separation yielded a concentrate assaying 40.77% Mn, 15·11 % SiO_2, 13.44% Fe, and 0.31% P, with a recovery of 60.9 % manganese. On heating, the concentrates improved in grade to 43.69% Mn, 16.19% SiO_2, 14.4% Fe and 0.33% P. The presence in the ore of garnet which is feebly magnetic and of a highly magnetic manganese mineral rich in iron (Vredenburgite) is mainly responsible for the low grade of the magnetic manganese concentrates.

Flotation failed to yield any satisfactory grade of concentrate.

Magnetic separation followed by electrostatic separation of the feebly magnetic middling recovered 71.8% Mn in a concentrate of grade 41.91% Mn, 0.21% P or 57.6% manganese in a combined concentrate of grade 43.24% Mn, and 0.22 per cent P. The electrostatic separator was found to be efficient for elimination of garnet yielding concentrates assaying 45.56% Mn and 0.22% P. Dry magnetic separation of the sample at —20 plus 35 and —35 mesh followed by wet magnetic separation of the highly magnetic at —100 mesh and by electrostatic separation of the feebly magnetic fraction gave the best results *viz.* a recovery of 51% manganese in a concentrate of grade 45.41% Mn and 0.27% P. This treatment yielded also a secondary concentrates of grade 35.24% Mn, 23.19% Fe, 9.16% SiO_2 and 0.08% P recovering another 20.8% of manganese.

Straight electrostatic separation yielded a concentrate assaying 43.15% Mn and 8.13% Fe with a recovery of 43.7% manganese only, since in the electrostatic separator it was not possible to recover manganese efficiently at fine sizes (—100 mesh).

Tabling followed by electrostatic separation of the table concenrates gives a product assaying 43.09% Mn and 9.32% Fe, with a manganese recovery of 46.6%.

A few gravity and magnetic separation tests were carried out separately with the plus and minus 4 mesh fractions of the original sample, as the fines were of a very low-grade. They failed to offer any improvement either in grade or recovery over the results obtained from the original sample.

It was observed that heating of the concentrates obtained during the tests, near the sintering temperature was found to improve their grades by about 3 units (% Mn).

Braunite being the predominating manganese mineral in the ore, all the concentrates obtained were high in silica (over about 12%). They were high in phosphorus (over 0.2%) due to its intimate association with the manganese minerals and it was not found possible to bring down the phosphorus to the metallurgical grade (at least 0.15%).

The presence in the ore of garnet and a strongly magnetic manganese mineral (Vredenburgite) high in iron in intimate association with the other manganese minerals, limits the degree of beneficiation possible by gravity and magnetic methods. The strongly magnetic mineral could be separated only at —100 mesh by wet magnetic separation. Gravity methods, magnetic separation or flotation under the conditions tested could not eliminate the garnet from the ore; electrostatic separation was found to be the only method capable of an efficient separation between the garnet and manganese minerals. The silica content of the beneficiated concentrates was higher than that permitted in standard grade manganese concentrates due to the fact that braunite, the predominating manganese mineral, contains in its pure state 10% SiO_2 and that the siliceous gangue was in intimate association with the manganese minerals. Phosphorus also was closely associated with manganese minerals and could not be brought below 0.2%.

The concentrates obtained by the above methods are in the form of fine powder and would require sintering or pelletising, before use in blast furnace. On sintering the grade of concentrate would improve by about 3 units (% Mn).

It will thus be seen that the ore is of a complex nature and the production of a concentrate of metallurgical grade with high recovery was not possible. By a combination of magnetic and electrostatic separation, two kinds of concentrates were obtained, the first high in manganese (over 48% Mn when sintered), low in Fe, but having over 12—13% SiO_2 and being high in phosphorus (0.25—0.3%). The second low-grade concentrate (assaying 35% Mn) was high in iron (23%) but low in phosphorus (0.08%). The total recovery was about 72% manganese (51 and 21% respectively in the two concentrates).

(*iv*) *Laboratory study on sample from Netra Mines, Balaghat district, Madhya Pradesh :*

The low grade manganese ore from Netra mine, Balaghat district, Madhya Pradesh assayed 29.24% Mn, 31.26% SiO_2, 2.60% Al_2O_3, 7.77% Fe, 4.30% CaO, 2.89% MgO, 0.26% P, 0.35% S and 1.92% BaO. A large bulk of the light gangue in the ore could be eliminated at —½" size, but the manganese minerals were very intimately associated with the gangue, requiring grinding to about 65 mesh for their liberation.

A high grade concentrate assaying more than 48% Mn can be obtained from this ore by tabling at —48 mesh, and magnetic separation of the table middling after grinding to about —65 mesh, but the manganese recovery in the concentrate could be expected to be only about 60% in view of the heavy loss during tabling and magnetic separation. The iron content of the concentrate, however, will be higher than the specified limit (6%).

A concentrate of 40% grade can be produced with a recovery of approximately 90% Mn by heavy media separation at —½" followed by, (i) jigging of the —6 mesh fraction mixed with the sink and float middling crushed to —6 mesh and (ii) magnetic separation of the jig middling.

A concentrate of grade about 42% could be obtained with a recovery of about 75% by jigging of the —3 plus 20 mesh fraction, tabling of the fines, and magnetic separation of the table middling.

Analyses of the concentrates obtained are as follows :—

Constituents %	(i)	(ii)
Mn	40.60	48.66
Fe	7.88	11.01
SiO_2	13.97	9.27
Al_2O_3	2.46	1.23
CaO	5.36	—
MgO	3.38	—
P	0.28	0.12
TiO_2	Trace	—
MnO	35.34	—
MnO_2	20.88	—
BaO	2.16	—
SO_3	1.30	—
Loss on ignition at 95°C	1.36	—

The rather high sulphur content in the concentrate is due to the presence of baryte in the ore.

(*v*) *Laboratory study on sample from Miragpur Mine:*

The sample, as received, assayed 34.45% Mn, 8.19% Fe, 19.72% SiO_2, 8.51% Al_2O_3, 0.098% P, 2.30% Ca, 2.08% Ba. The ore minerals were braunite and psilomelane with a little cryptomelane

Garnet was the major gangue. Hematite, quartz, a manganese pyroxene, a manganese amphibole, feldspar, clay and ochre formed the rest of the gangue. They were all in extremely fine inter-growth with the ore minerals. Some garnets isolated from the sample, assayed 27.36% Mn, 5.1% Fe, 35.51% SiO_2, 17.4% Al_2O_3 and 3.8% CaO.

Sink and float tests confirmed the futility of adopting gravity methods of beneficiation for this ore.

Flotation was fairly effective in discarding quartz and garnets, but the concentrate assayed only 40.78% Mn, 7.50% Fe, 6.71% Al_2O_3, 7.63% SiO_2, 0.098% P with a recovery of 30.8% Mn. On heating to a temperature of 800°—900°C., the manganese content increased to 44.63%.

Straight electrostatic separation was also successful in eliminating most of the free garnets and quartz at the sizes treated, but the concentrate assayed only 39.85% Mn, 7.42% Fe, 6.48% Al_2O_3, 7.42% SiO_2, and 0.088% P with a recovery of 40.3% Mn. On heating to a temperature of 800°—900°C., the manganese content increased to 43.60%.

Reduction roast followed by magnetic separation of —48 mesh could recover 56.6% Mn in a concentrate of grade of 43.06% Mn, 6.02% Fe, (Mn/Fe ratio 7.15), 18.08% SiO_2, 10.36% Al_2O_3 and 0.099% P. The improvement in grade obtained by this method, was more due to loss in weight during reduction roast than to the efficiency of the separation. The concentrates contained most of the garnets and hence their SiO_2 and Al_2O_3 were high.

Reduction roast followed by magnetic separation and electrostatic separation yielded a product of grade 46.23% Mn, 6.6% Fe (Mn/Fe ratio 7.0), 11.19% SiO_2, 8.23% Al_2O_3 and 0.10% P but with a recovery of only 30% Mn.

The ore was of a highly complex nature. Extremely fine intergrowth of the manganese minerals with the gangue limited the degree of beneficiation possible by physical methods of ore dressing. There was heavy loss of manganese because (a) garnet, was the major gangue and itself assaying 27.36% Mn had to be eliminated (b) much slime was invariably produced during the grinding necessary for a fair liberation of the minerals, and t is had to be discarded completely for the subsequent concentration processes. Hence, the recoverable manganese was quite low. Again fine intergrowth of the manganese minerals with the gangue restricted also the obtainable grade. Garnet and quartz could be eliminated to a large extent by flotation or electrostatic separation. The concentrate obtained conformed to grade (B) of the metallurgical specification. It is noteworthy that phosphorus content was very low in the concentrates. The concentrates are in the form of fine powder and would need to be sintered or nodulised before use. If a higher grade is desired hydrometallurgical methods may have to be adopted for beneficiation of this ore.

(*vi*) *Laboratory study on sample from Kodur Mines (Alluvial ore), Andhra Pradesh :*

A sample of low-grade manganese ore (alluvial) from Kodur mines was subjected to beneficiation tests by jigging, tabling, magnetic separation and flotation. The manganese minerals in the ore were psilomelane, pyrolusite, and vredenbergite. The gangue minerals were quartz, decomposed feldspar and limonite. Traces of sillimanite and few grains of tourmaline were also present.

The ore as received assayed 33.94%Mn, 4.35% Fe, 14.01% SiO_2, 8.5% Al_2O_3, 8.65%Ba and 0.49%P.

Of the various concentration methods employed, high intensity magnetic separation gave the best results. The recovery of manganese was 86.4% in a concentrate analysing 43.2% manganese when the grind of the ore was −20 mesh.

Jigging the plus 20 mesh fraction followed by tabling of the roll-crushed jig tailing alongwith the original −20 mesh fraction, yielded a combined concentrate assaying 44.79%Mn, 2.31%Fe, 5.63% SiO_2, 5.99% Al_2O_3, 0.33%P and 9.67% Ba, with a manganese recovery of 67.7%.

Straight tabling of the ore after grinding to −14, −28 and -35 mesh yielded concentrates assaying 44.82%, 45.02% and 45.31% Mn respectively with corresponding recoveries of 65.3%, 62.2% and 58.6% manganese.

In all the cases, sintering of the concentrates was found to increase the manganese grade by 4 to 5 units. (% Mn).

Phosphorus content was high in all the concentrates varying from 0.37 to 0.28% P and hence for the production of ferro-manganese the concentrates would be suitable only for blending with low phosphorus ores or concentrates. It is not known whether the high barium content in the mineral psilomelane which limited the grade of concentrate to about 45% would be regarded as acceptable by purchasers, its presence may in fact be useful as a fluxing ingredient.

Flotation did not produce any encouraging result in lowering the phosphorus contents of the concentrates.

(*vii*) *Laboratory study on sample from Kodur Mines (Bed Ore), Andhra Pradesh.*

The sample as received contained 33.49%Mn, 13.92% Fe, 8.45% SiO_2, 7.45% Al_2O_3, 0.29%P and 2.34% Ba. The chief manganese mineral was psilomelane with smaller quantities of braunite, pyrolusite and, vredenbargite. The gangue minerals present in the ore were clay, quartz kaolin, limestone, limonite, garnet and traces of sillimanite.

Jigging in two stages followed by tabling produced a combined gravity concentrate assaying 44.03%Mn and 10.96% Fe with a manganese recovery of 72.1%. The grade after sintering would increase to 48.92%.

Reduction roast of the combined concentrate followed by magnetic separation gave a product assaying 56.01%Mn, and 5.69% Fe with a recovery of 60.0% Mn.

Straight tabling of the –20 mesh sample after classification produced a combined concentrate assaying 44.82% Mn with a recovery of 62·5% Mn.

Magnetic separation after crushing the sample to different sizes gave products assaying between 37.56% to 40.40% Mn and 13.79% to 15.38% Fe with recoveries from 80.2% to 89.1% Mn.

Reducing roast of –10 mesh sample followed by magnetic separation after crushing to –35 mesh yielded a product containing 49.29% Mn and 6.37% Fe with a recovery of 50.8% Mn.

Reducing roast of –10 mesh sample after washing and rejecting the 48 mesh fraction, gave a non-magnetic product in a weak magnetic field, assaying 50.25% Mn and 6.30% Fe with a recovery of 65.3% Mn.

A low grade alluvial manganese ore received from the same source was low in iron. The similarity of the samples with respect of their beneficiation suggests that both the samples could be mixed in proportion before treatment so that the manganese/iron ratio in the concentrate could be kept within the required specifications and at the same time a higher overall recovery of manganese could be obtained. However, the concentrates would require to be blended with low phosphorus ores or concentrates if used for the production of ferro-manganese.

(viii) Laboratory study on sample from Marivalasa Mines (Salur) Andhra Pradesh:

A low grade manganese ore from Marivalasa, Salur, Srikakulam district assaying 28.63% Mn, 18.44% SiO_2, 12.68% Fe, 6.19% Al_2O_3 and 0.20%P was received from Messrs Devidayal (Sales) Limited, Bombay, for beneficiation tests.

The manganese minerals in the sample were mostly oxides *viz.*, psilomelane and pyrolusite with quartz, garnet and limonite (ochre) as the principal gangue minerals.

Jigging the –4 plus 35 mesh fraction of the sample produced a jig concentrate assaying 40.42% Mn, 10.02% Fe and 0.29%P with a recovery in the product of 60.5% Mn. Straight tabling did not improve the results. The gravity concentrates were contaminated with limonite and garnet. The concentrates were also high in phosphorus.

Though garnet floated well, flotation did not yield a tailing (manganese concentrate) of a high grade as it was still contaminated with ochre and quartz.

Reduction roasting of the –4 mesh washed ore followed by magnetic separation at -20 mesh produced a concentrate assaying 47.10%Mn, 6.8% Fe (Mn/Fe ratio 6. 9:1) with a recovery of 64.2% of the manganese

A concentrate of grade 48% Mn could not be produced due to contamination with garnet.

Reduction roasting of -4 plus 35 mesh fraction of the ore after rejecting the bulk of the garnet in the -35 mesh fraction followed by magnetic separation at -20 mesh produced a concentrate assaying 50.10% Mn and 6.29% Fe (Mn : Fe ratio 7. 9:1) with a recovery of 47.7% of the manganese. A higher recovery of 71.6% of the manganese could be obtained in a concentrate of grade 48.18% Mn but with a Mn/Fe ratio only 5·5:1. A concentrate of grade over 48% Mn could, however, be expected with a Mn/Fe ratio of 7.0 and with a recovery of about 60% of the manganese.

The silica content of the concentrate was high due to contamination with garnet. Although the bulk of the garnet was rejected in the -35 mesh fraction, an appreciable amount entered the manganese concentrate in the magnetic fraction. The manganese concentrate was slightly higher in phosphorus (0.21%) than the original ore but, as only a few grains of apatite could be observed under the microscope even in the concentrates, flotation tests were not carried out for lowering the phosphorus content.

The concentrate may have to be blended with a suitable high grade manganese ore for the manufacture of ferromanganese.

(*ix*) *Laboratory study on sample from Chipurupalli, Andhra Pradesh:*

The sample assayed 25.82% Mn, 25.16% SiO_2, 10.89% Fe and 0.13% P, and consisted mainly of psilomelane, wad and limonite, besides some quartz and garnet. The bulk of the limonite and garnet was present as fines and the later could be almost completely eliminated by rejecting the -20 mesh fraction of the sample crushed to $-3\frac{1}{2}$ mesh, for a manganese loss of about 16%. The psilomelane grains were coated with limonite, which could not be removed easily.

A good grade of concentrate could be obtained by jigging employing coarse feeds as well as by electrostatic separation of the coarser table concentrates. Garnet could be efficiently eliminated by electrostatic separation but the concentrates obtained from the finer feeds were contaminated with limonite.

The best grade of concentrate that could be obtained by gravity methods was by jigging of the $-3\frac{1}{2}$ plus 20 mesh fraction of $-3\frac{1}{2}$ mesh ore. It gave a concentrate assaying 47.99% Mn with a recovery of 59.2%. Loss of manganese in the tailing was 24.3% which was due to the porosity of some of the manganese minerals, especially wad which could not be recovered. By subjecting the jig tailings to reduction roasting it is expected that a high grade concentrate could be obtained with a further recovery of about 12%. The concentrate obtained by jigging assayed 47.99% Mn, 8.54% Fe, 0.17% P, 2.43% SiO_2 and 5.22% Al_2O_3.

Tabling of the ore after removal of the garnet fraction (—20 mesh) gave a concentrate contaminated with limonite and assaying 46·99% Mn with a recovery of 59.3%. The table tailing on reduction roasting gave a feebly magnetic concentrate assaying 51.49% Mn with a further recovery of 9.9%. When these concentrates were mixed, the combined product assayed 47.17% Mn with an overall recovery of 69.2%.

Jigging the —14, —28 mesh fraction of — 14 mesh ore and electrostatic separation of the —28 mesh fraction after close sizing gave a combined concentrate assaying 47.08% Mn with an overall recovery of 69.5%. Electrostatic separation effected a fairly clean removal of the garnet but limonite contaminated the finer electrostatic concentrates.

Tabling of the —14 mesh ore followed by electrostatic separation of the table concentrates after close sizing gave a combined concentrate assaying 46.99% Mn with an overall recovery of 70%.

Roasting at 900° C. was found to improve the grade of a low-grade concentrate assaying 44.73% Mn to 51.86% Mn. A similar roast with another concentrate assaying 43.08% Mn improved the grade to 49.50%.

Reduction roasting at 560° C. of the $-3\frac{1}{2}$ mesh washed ore gave a concentrate assaying 49.99% Mn with a recovery of 69.8%. A similar test employing a $-3\frac{1}{2}$ plus 20 mesh wet screened garnet-free fraction gave a concentrate assaying 50.47% Mn with a recovery of 70.6%. The later concentrate assayed :—

Mn	50.47 per cent
Fe	8.39 per cent
P	0.17 per cent

The iron content in the concentrate is slightly higher than the permissible limit. As one of the fractions obtained during magnetic separation was found to assay even 54% Mn and 2.8% Fe, it could be concluded that a concentrate with a slightly lower iron content, could be produced to meet the specification by suitable control of magnetic field, with a slightly lower recovery. The concentrates assayed 0.17% P which could perhaps be tolerated.

A marketable grade of concentrate can, therefore, be obtained from this ore. For most purposes the final product will require pelletising or sintering, which will further improve the grade by another 6—7 units of manganese.

(*x*) *Laboratory study on sample from Shivarajpur Mines, Gujrat :*

The low grade manganese ore fines received for investigation assayed 36.5% Mn, 10.25% Fe, 6.94% Al_2O_3, 19.07% SiO_2 and 0.38% P. The sample as received is in the form of fines, most of it being —4 mesh. The plus 20 mesh fraction constitutes 50.5% by weight of the ore while 21.7% is finer than 200 mesh.

The principal gangue minerals present in the ore are quartz, decomposed felspar, limonite clay, ochre and mica. Psilomelane is the predominant manganese mineral with minor amount of pyrolusite and braunite.

Jigging of the plus 14 mesh fraction of the ore as received and tabling of the roll-crushed jig tails and the original −14 mesh product after classification, recover 75.4% Mn in a combined concentrate assaying 46.3% manganese. Sintering increases the grade to 51.0% manganese.

Straight tabling of the ore (−14 mesh) after hydraulic classification yields a concentrate of grade 47.9% manganese with a recovery of 61.8%. Retreatment of the middling is expected to increase the recovery to 70.0%.

A still higher grade of concentrate *viz.* 49.1% manganese can be obtained at the sacrifice of recovery of 57.8%. In all the cases, sintering of the concentrate was found to increase the grade by 4 to 5 units.

Flotation as well as magnetic separation of a gravity concentrate reduced the phosphorus content only from 0·29% to 0.26%, which is higher for metallurgical purposes. Further reduction cannot be effected due to the intimate association of phosphorus with the manganese minerals.

The ore after concentration and sintering as described above could therefore best be regarded as a material which could be blended with low-phosphorus concentrates or high-grade ores for the manufacture of ferro-manganese.

(*xi*) *Laboratory study on sample from Mansar Mines :*

A sample of low-grade manganese ore from Mansar Mines, Maharashtra, was subjected to beneficiation tests by magnetic separation, gravity and flotation methods. It consisted essentially of braunite some psilomelane and a little pyrolusite, the gangue minerals being quartz, mica, clay, barite, apatite, rhodonite and calcite.

The sample as received assayed 32.67% Mn, 27.48% SiO_2, 10.13% Fe and 0.46% P.

Jigging the −10 and plus 14 and −14 plus 28 mesh fractions followed by tabling of the −28 mesh fraction and jig tailings ground to −28 mesh, resulted in a combined concentrate assaying 45% Mn with a manganese recovery of 75.8%. The grade of concentrate is low, due to the nonliberation of the manganese minerals in the coarse fraction.

Straight tabling at −20 mesh yielded a combined concentrate assaying 45.2% Mn with a recovery of 68.4% manganese. The results could not be improved by tabling at −28 mesh also. Straight abling at −48 mesh recovered 61.7% manganese in a concentrate

of grade 47·71% Mn, 12·92% SiO_2, 12·84% Fe and 0·24% P. The recovery could be improved to over 69% by grinding the middling and returning it to the tabling circuit. On heating, the product improved in grade to 48·77% Mn, 13·21% SiO_2, 13·12% Fe and 0·25% P. Though the grade and recovery of manganese are satisfactory, the phosphorus content in the concentrate is rather high.

Primary flotation of the original sample in an alkaline circuit using sodium silicate and a mixture of oleic acid and diesel oil (1:1 by weight) as frother-collector followed by cleaning of the primary manganese rich froths at a pH of 5·6 recovered 43·1% manganese in a product assaying 46·43% Mn and 0·07% P. If the refloat middling and tailing are returned to the circuit as in practice a total recovery of about 60% could be expected from the same grade of concentrate.

Straight magnetic separation of the original sample divided in −20 plus 48 and −48 mesh fractions, recovered 89·1% manganese in a concentrate assaying 42·90% Mn and 0·29% P. The magnetic products were further enriched by tabling and flotation methods.

Magnetic separation followed by tabling of the magnetic product produced a concentrate which assayed 48·76% Mn, 11·44% SiO_2, 11·2% Fe and 0·16% P, with a manganese recovery of 65·3%. On heating, the product improved in grade to 49·22% Mn, 11·55% SiO_2 11·31% Fe and 0·16% P. This combination process has yielded the best grade of manganese concentrate low in phosphorus and with high manganese recovery.

Magnetic separation followed by flotation of the combined magnetic products yielded a concentrate assaying 47·94% Mn, 13·08% SiO_2, 10·92% Fe and 0·03% P, with a manganese recovery of 54·4%. By returning the refloat tailing to flotation circuit, a further recovery of about 9% manganese can be obtained bringing the overall recovery to over 63%. On heating, the product improved in grade to 48·58% Mn, 13·23% SiO_2, 11·05% Fe and 0·03% P. In this method, the phosphorus content is reduced to trace and a high grade of manganese concentrate is also obtained with recovery only slightly lower than in the previous method of magnetic separation followed by tabling.

Investigation on the low grade manganese ore from Mansar mines has shown that the ore is amenable to beneficiation by ore-dressing methods. Magnetic separation followed by tabling or floatation of the magnetic products raised the ore to the ferro-manganese grade with a good recovery. The phosphorus content has also been brought within the specifications. Since braunite, the chief manganese mineral in the ore, contains in its purest state about 10% silica, it is not possible to reduce the silica content of the concentrate further by ore-dressing methods. Iron is present in complex association with manganese. Roasting followed by magnetic separation of the concentrate could not lower the iron content.

Heating at high temperature is found to improve the grade of manganese concentrate by one unit (% Mn). The concentrates are in the form of fine powder and hence would require sintering or nodulising for use in blast furnace.

(*xii*) *Laboratory study on sample from Nagri-Joda, North Kanara, Mysore:*

A low grade ferruginous manganese ore sample assaying 33·30% Mn, 19·60% Fe, 3·20% SiO_2, 4·01% Al_2O_3 and 0·02% P, was received for beneficiation tests from Nagri-Joda in Supapetha, North Kanara. The manganese minerals were chiefly psilomelane and little pyrolusite. Limonitic ochre was the main gangue. Alumina was mostly in the form of laterite. Straight magnetic separation was not efficient in removing the iron bearing minerals. Flotation also did not yield satisfactory results. Roasting in a reducing atmosphere under certain conditions converted the iron-bearing minerals into magnetite, which could be removed from the manganese minerals by magnetic separation; tests on this method were carried out on the original as well as the washed samples and the results presented graphically. Encouraging results were obtained. For example, the original sample was shown to yield a manganese concentrate of grade 56% Mn and 6% Fe, with a manganese recovery of 72%, while a similar concentrate from the washed sample would assay 55·8% Mn and 6% Fe with a recovery of 70% manganese. Higher manganese recoveries upto 82% and 79·5% in case of unwashed and washed samples respectively could be obtained in concentrates with an iron content of 8% (Mn 54·2%) which is permissible according to a recent American specification. The SiO_2 and Al_2O_3 contents of the above concentrates would also be within specification. Generally, from the deslimed sample concentrates of higher grade are obtained but with slightly lower manganese recovery than from the unwashed ore.

It may be pointed out that the magnetic product obtained might also be of value as mangani-ferrous iron ore or possibly for reduction to spiegeleison.

All the products obtained are in the form of fine powder and therefore sintering would be required to meet the size specification.

(*xiii*) *Laboratory study on sample frcm Nagri-Joida* (*D Grade Ore*) *North Kanara:*

A low-grade ferruginous manganese ore marked 'D' grade from Nagri-Joida, North Kanara, assaying 34·71% Mn, 18·49% Fe, 0·03% P, 3·93% SiO_2, 6·70% Al_2O_3 was received for beneficiation tests from Messrs. Lalbhai Patel and Co. Ltd., Bombay. The Manganese mineral was chiefly psilomelane with small quantities of pyrolusite. The primary gangue mineral was limonitic ochre. Alumina was present mostly as laterite.

Reduction roasting of the ore at −3 mesh at 500°−560°C. follwed by magnetic separation of the reduced ore at −20 mesh yielded a

manganese concentrate in the non-magnetic fraction for Mn/Fe ratios between 6 and 9. The recoveries of manganese in the concentrates varied from 87% to 78·5%. Grades varied from 52·1% to 55·5% Mn. Washing of the ore before reduction was found to be of advantage only when a Mn/Fe ratio in the concentrate higher than 8 was required.

The concentrate obtained from the ore by the process of reduction was very low in phosphorus, Al_2O_3 and SiO_2 and so should be ideal raw materials for production of high grade, low phosphorus ferro-manganese. The iron-rich magnetic concentrates could be utilised in the blast furnace as a source of manganese in pig iron.

This and the other ferruginous manganese ore from the same locality because of their mineralogical and chemical compositions as well as their beneficiation methods suggested that the two samples could be mixed prior to beneficiation.

(*xiv*) *Laboratory study on sample from Sandur Mines, Mysore :*

A sample of ferruginous manganese ore from Sandur mines, Mysore, assayed 30·18% Mn, 21·9% Fe, 0·99% SiO_2, 12·40% Al_2O_3 and 0·03% P. The manganese minerals in the ore were pyrolusite and psilomelane. The principal gangue mineral was ferruginous ochre with some ferruginous laterite, magnetite and quartz.

Straight magnetic separation as well as magnetic separation of the reduced ore (unwashed) did not yield satisfactory results.

Reduction roast of −3 mesh washed sample followed by magnetic separation at −200 mesh produced a concentrate assaying 52·6% Mn, 7·15% Fe and 0·04% P with a manganese recovery of 54·9%. Magnetic separation at −28 mesh produced a concentrate assaying 54·4% Mn, 8·5% Fe and 0·03% P, but the recovery of manganese was only 42·5%. These concentrates were very low in phosphorus and so could be used for the production of low-phosphorus standard ferro-manganese. Manganese recoveries obtainable from this ore were comparatively low, due to very intimate association of the manganese and iron minerals.

(*xv*) *Laboratory study on sample from Keonjhar, Orissa* (*Tisco Ore*)*:*

The ferruginous manganese ore from the Tisco mines can be successfully beneficiated. Washing of the ore at a grind of −3 mesh with the rejection of material finer than 28 mesh recovered 85·5% Mn and 82·7% Fe in the coarser product while effecting a rejection of silica and alumina in the fines to the extent of 65·8% and 42% respectively. The washed product (−3 plus 28 mesh) assayed 27·7% Mn, 31·6% Fe, 4·68% Al_2O_3 and 2·7% SiO_2.

Magnetising reduction of the ore at 500C. followed by crushing the material to −10 mesh and magnetic separation yielded two useful products which could be employed in the steel industry, so that recovery

of manganese and iron can be taken as nearly 90%, the remainder going with the washed slimes.

The iron-rich magnetic concentrate containing 60 to 50% iron and 10% to 15% manganese can be employed in the blast furnace as a source of manganese in the pig iron. The manganese rich non-magnetic concentrate containing 55 to 62 manganese and 5% to 3·2% iron, should be an ideal raw material for the production of high grade ferro-manganese. The advantages of employing this material for ferro-manganese production over the use of a normal high grade are as follows :—

(i) The ratio of manganese to iron is very high thus making it possible to get a very high grade of ferro-manganese.

(ii) The percentage of slag-forming constituents is very low (above 7·5%) and should decrease considerably the loss of manganese in the slag.

(iii) Finally, the manganese is present in the manganous state (MnO). This would decrease the amount of coke necessary to produce ferro-manganese, *i.e.*, it would decrease that actually needed for reduction nearly 50%, thereby minimising, to some extent, the introduction of phosphorus into the ferro-manganese.

(*xiv*) *Laboratory study on sample from Siljora, Keonjhar District, Orissa :*

A sample of ferruginous manganese ore from Siljora, Keonjhar district, Orissa, assayed Mn 37·55%, MnO_2 56·62%, Fe 12·46%, SiO_2 7·56%, Al_2O_3 6.45% and P. O·086%. The manganese minerals in the sample were psilomelane, pyrolusite and maganite. The principal gangue minerals were hydrous iron oxides with smaller amounts of hematite.

Straight magnetic separation of the sample ground to −20 mesh did not yield satisfactory results.

Reduction roast of −3 mesh unwashed sample followed by magnetic separation after grinding to −14, −28 and −35 mesh sizes, produced high grades of concentrates with a Mn/Fe ratio of 7:1 and with high manganese recoveries. The magnetic separation at various sizes yielded almost the same grade of concentrates with similar manganese recoveries. The −35 mesh samples produced a concentrate assaying 51·6% Mn with manganese recovery of about 90·5% and a Mn/Fe ratio of 7:1. The grade of concentrate produced from the coarest feed (−14 mesh) was slightly lower (50·8% Mn) but the manganese recovery (about 90%) in the product remained almost the same. Though the silica plus alumina in the concentrate was somewhat high, the concentrate however can be used for production of standard ferro-manganese.

Reduction roast of −3 mesh washed sample followed by magnetic separation at −28 mesh, yielded a better grade of concentrate, assaying 53·0% Mn, (Mn/Fe ratio 7:1) but with a reduced recovery of about 85·7%.

(xvii) Laboratory study on sample from Barajamda, Keonjhar District, Orissa :

The low grade manganese ore containing free silica as the principal gangue could be beneficiated to yield a concentrate with a Mn/Fe ratio of 8:1 and low in phosphorus. The ore is amenable to simple concentration methods, which can be employed even by small operators, but the concentrates will be in the form of fines, which could be utilised as such for ferro-manganese production in electric furnaces.

(xviii) Laboratory study on sample from Banswara District, Rajasthan :

A sample of low grade manganese ore from Banswara was received from the Director of Mines and Geology, Government of Rajasthan. The sample was reported to be representative of low grade deposits of Kalakhunta, Sionia, Sagwa, Itala, Tambeshra and Talwara in Banswara district. As received, it assayed 38·82% Mn, 5·0% Fe, 6·7% Al_2O_3, 21·85% SiO_2, 0·15% P, 1·51% Ba and 0·42% CaO. The principal manganese minerals present were braunite, and needles of polianite, quartz, garnet, hematite and magnetite, which were the gangue minerals, were in intimate inter-growth with the manganese minerals. The garnet was of manganiferous variety.

Straight magnetic separation of –35 mesh sample after sizing, produced a strongly magnetic product assaying 48·87% Mn but with a low recovery of only 12·7% Mn. Employing a finer feed did not yield better results.

Tabling employing –65 mesh and –150 mesh feeds after hydraulic classification did not produce encouraging results.

Soap flotation of the sample ground to 91·9%–200 mesh produced a refloat concentrate assaying 47·69% Mn with a recovery of 22·4% Mn. Tests employing cationic reagents for flotation of garnet from manganese were not successful.

Electrostatic separation of –65 mesh sample after sizing, produced a combined concentrate assaying 47·06% Mn with a recovery of 30·2% Mn. A similar test but employing a deslimed feed produced better results, the combined concentrate assaying 48·0% Mn, 4·21% Fe, 2·48% Al_2O_3, 8·19% SiO_2 and 0·093% P with a recovery of 60·3% Mn and a Mn/Fe ratio of 11·4:1. This conformed to the specifications laid down for the metallurgical grade of ore. When the middling products were also mixed with the concentrates the grade of the mixed product slightly dropped to 47·04% Mn but the recovery improved to 64·8% Mn. This indicated that desliming the feed was desirable for efficient separation of manganese from gangue minerals.

Electrostatic separation employing a –48 mesh deslimed feed, yielded a combined concentrate assaying 47.10% Mn, 4.51% Fe, 2.63% Al_2O_3, 8.46% SiO_2 and 0.11% P with a recovery of 70.4% Mn and a Mn/Fe ratio of 10. 4:1 in the product. This concentrate also conformed

to the metallurgical grade of ore. The recovery would improve to 81% Mn by mixing slime also with the concentrates, in which case the grade of concentrate would be 46·19% Mn.

(*xix*) *Laboratory study on sample from Kamji Mines, Banswara District, Rajasthan ;*

A low grade manganese ore from Kamji mine in Talwara, Banswra, Rajasthan, assaying 21·74% Mn, 14·23% Fe, 18·22% CaO, 3·46% SiO_2, 0·58% P and 1·89 % Al_2O_3 was received from R. B. Seth Mulchand Suganchand for beneficiation tests.

It was a complex ore in which the manganese minerals psilomelane and pyrolusite were in intimate association with calcite which was the chief gangue mineral. Hydrous iron oxides wih minor quantities of quartz and apatite were also present. Straight tabling of the sample at −35 mesh after classification produced a combined concentrate assaying 30% Mn with a recovery of only 19·4% Mn. The loss of manganese in the slime was over 50% indicating that the manganese minerals were soft. Reduction roasting of the −3 mesh unwashed sample followed by magnetic separation at −20 mesh produced a concentrate assaying, 34·7% Mn. 4·6% Fe (Mn : Fe ratio 7·1:1) and 0·45% P with a recovery of 57·6% Mn,

Magnetic separation at −20 mesh of the roasted product after desliming produced a concentrate assaying 35·8% Mn, 5·45% Fe (Mn : Fe ratio 6·5:1), 0·39% P, 18·6% CaO, 1·71% Al_2O_3 and 3·76% SiO_2 with a recovery in the product of 66·4% Mn.

Reduction roasting of the −3 mesh washed product followed by magnetic separation at −20 mesh yielded a manganese concentrate assaying 34·5%, Mn, 6·6% Fe (Mn : Fe ratio 5·2:1), 0·38% P, 2·23% Al_2O_3, 4·4% SiO_2 and 14·9% CaO with a recovery of 58·4% Mn. Magnetic separation at finer sizes did not improve the results.

Though after beneficiation a Mn/Fe ratio of 7 (metallurgical grade) could be produced, a high grade concentrate could not be obtained from the ore due to intimate association of calcite with the manganese minerals. Phosphorus was also very high in the concentrate. A few flotation tests carried out to separate apatite from the ore were not successful. The slime produced during the test was high in manganese content due to the presence of pyrolusite in the ore which being soft was ground finer and collected in the slime.

The ore, even after beneficiation, still remained a low grade ore high in CaO and P though the Mn/Fe ratio could be improved to that of the metallurgical grade (7). The low grade of concentrate that could be produced from this ore should not be an adverse factor against its use for ferro-manganese production, because its high CaO content will eliminate addition of limestone for fluxing. But the phosphorus content is too high and the ore will have to be blended with low phosphorus ores, to make it suitable for ferro-manganese production.

If the sample of low grade manganese described at (i) above is more representative of the Banswara manganese ore deposits, the present ore could perhaps be blended with the other siliceous ores of the locality which are low in P, and the combined ore treated in one mill by electro-static separator. The blending with siliceous manganese ore will not only dilute the phosphorus content of the ore under investigation but will also provide the necessary silica to the high CaO content of the latter (18.6%), ore for fluxing purposes.

CHAPTER VI

TRANSPORTATION AND PORT HANDLING

6.00 The cost of transportation of minerals from mines to centres of consumption is an important factor which determines their saleability in the International market. In India transportation charges (including road and rail transport and port handling) alone constitute 40 to 50% of the f.o.b. cost of manganese ore. Comparative data of the costs of road and rail transportation of manganese ore in other countries are not available. However, the observation made by National Council of Applied Economic Research in their study entitled "Cost-price structure of iron ore" that for 280 km haul, the railway freight on iron ore is 100% higher than the prevailing rates in U.S.A, is substantially true in respect of manganese ore also.

The shipping freight rates from the ports in India to the countries of export, for the reasons explained hereinafter, are higher than the corresponding rates for other manganese producing countries. In Table-I an attempt has been made to compile figures of the distance and the present freight rates from the ports of various manganese exporting countries to their principal buyers. It will be seen from the table that India is not favourably located in relation to American and European markets for export of manganese ore as compared to other producers in Africa and South America. Besides geographical distance between exporting and importing countries there are other factors which have important bearing on the ocean freight *e.g.* modern mechanised facilities for loading vessels at the ports and the use of large ore carriers for transportation of ore. In this respect the conditions at Indian ports are far from satisfactory. The net result is that the carrying costs of Indian manganese ore are high, which is responsible for making manganese ore costlier than corresponding ore from other countries.

An attempt has been made in this chapter to study the problems of road and rail transport and ocean shipping in so far as these have a bearing on the exports of manganese ore from India. Remedial measures, wherever possible, have been suggested to improve the prevailing conditions. A brief account of the handling and transport conditions in some of the important manganese producing and exporting countries has been given first.

Table I : Freight Rates on Manganese Ore During 1963

Exporting country	Importing countries	Appx. distance in nautical miles	Freight per ton f. i. o. t./ f. i. o. (in $)
South Africa (Durban) .	U. S. A. (New York) .	7,600	7·00
	U. K. (London) . .	6,900	6·40
	France (Marseilles) . .	6,100	5·60
	Holland (Rotterdom) .	7,000	5·60
	Belgium (Antwerp) . .	6,900	4·80/5·08
	Japan (Yokohama) . .	7,700	8·40
Ghana (Takoradi) .	U. S. A. (New York) .	4,900	5·25
	U. K. (London) . .	4,100	6·44
	Netherlands . . .	N.A.	4·90
Morocco (Algiers) .	U. S. A. (New York) .	3,200	5·40
	Poland	N.A.	4·55
	Germany West (Hamburg)	2,000	N.A.
	France (Merseilles) . .	400	N.A.
Mozambique (Mozambique).	U. S. A. (New York) .	8,000	6·75/7·10
	Canada (Quebec) . .	8,000	8·50
Rep. of Congo (Point Noire).	U. S. A. (New York) .	4,900	6·25
	Germany West (Hamberg)	4,400	N.A.
	Italy (Naples) . .	4,100	N.A.
	Belgium (Antwerp) . .	4,200	N.A.
Brazil (Macapa) . .	U. S. A. (New York) .	2,900	2·75/4·25
	France (Marseilles) . .	4,000	3·50
	U. K. (London) . .	4,100	N.A.
	Poland	4,500	N.A.
U. S. S. R. (Odessa) .	Belgium (Antwerp) . .	3,500	3·22
	U. K. (London) . .	3,500	6·30
	Japan (Yokohama) . .	9,000	3·36
	Germany West (Hamberg)	3,800	3·22
India (Calcutta) . .	U. S. A. (New York) .	9,800	8·50
	U. K. (London) . .	7,900	8·75
	Japan (Yokohama) . .	4,500	5·32
	Germany West (Hamberg)	8,200	5·60
	France (Marseilles) . .	6,200	N.A.
	Sweden (Stockholm) .	8,700	N.A.
	Belgium (Antwerp) . .	7,950	7·42
	Italy (Naples) . . .	5,800	7·00

SOURCE : Stelp and Leighton Limited.
N. A. : Not available.
$: U. S. dollars.
Distance and Freights are approximate.

6.01 Brazil

At Amapa, which is the most important manganese mine in this country broken manganese ore from the mines is loaded into 22 ton and 25 ton diesel dump trucks by 2½ cu. yd. diesel operated shovels and trucked about 1½—2 miles over good road to crushers and screens etc. The washed ore is drawn from the bottom of the 550 ton ore bins into rail-road cars on a single loading track under the bins which was designed with a slight grade, permitting an entire ore train to be loaded and assembled by gravity, with no locomotive required. A 70 ton car can be loaded in about one minute. The ore goes by train to Porto Macapa, a distance of 122 miles. The rail road terminal harbour installations are located on the northern shore of the north channel of the Amazon estuary, well sheltered by the Santana Island, about 13 miles upstream from the city of Macapa. The northern channel has deep water close to shore at the port site. Vessels to be loaded tie up along a floating steel fender structure, 810 ft. long and 40 ft. wide, anchored to two mooring structures. The ore reaches the port in 70 ton bottom-dump cars. Two cars at a time are emptied into a hopper where the ore is fed by two reciprocating pan feeders to a 36 inch belt conveyor, which in turn delivers the material to a second 36-in conveyor serving both for loading the ore into vessels at the dock and for stock-piling at the adjacent stockpile field. Modern ore carriers upto 45,000 tons in size can be accommodated at the dock. The capacity of the stock-pile field is 1,20,000 tons. Ore from the stock-pile is reclaimed by two 6 cu. yd. electric shovels. These load into two self propelling hoppers with reciprocating feeders which deliver the ore to the conveyor for loading. Reclamation and loading capacity is 2,000 tons per hour. The sea-freight to U.S.A. amounts to about $3 per ton only.

6.02 U.S.S.R.

The mining areas of Chiature, Georgia are serviced by an aerial tramway to a 21 mile spur of the main line of the Trans-Caucasus railways which carries the ore to Betum (126 miles) or Poti (90 miles) on the Black sea.

6.03 Union of Gabon (West Africa)

The mines are situated in four plateaus near Franceville deep in the interior of the Gabon Republic. A 45 miles cable-way with a capacity of 850,000 tons a year has been built to carry the ore concentrates from the mines to a rail-head at M' Binda. A 180 mile rail-road has been built from M' Binda to a junction point near Dolisie on the Congo Ocean rail road which runs into Atlantic Ocean port of Pointnoire. Automatic loading facilities are provided at the port.

6.04 Union of South Africa

The Postmasburg field is connected by rail with Kimberly which is the main port for exports of manganese ore. The distance between Postmasburg to Kimberly is about 130 miles. (It has not been possible to get more detailed information).

6.05 Ghana

The manganese ore deposits of Nsuta, district Wassaw are situated alongside the Sekondi-Kumasi railway line, some 39 miles from the modern port of Takoradi. Reportedly, Takoradi has excellent mechanical loading facilities for limited manganese ore traffic.

6.06 India

The modes of transportation used in India are the following :—

(a) Road

(b) Rail

(c) Ropeways

(d) Inland water

(a) *Road.*—The most efficient mode of transporting large volume of mineral products from mine to the port is at present rail transport carrying ore from the mine siding to rail siding at the port. But in India such rail facilities are available only to one or two larger manganese producing units. The majority of producers have to carry their ore by road transport to the nearest rail-head from where it is transported by the railway system to ports. The following table gives the 'lead' from various producing sectors to the nearest rail-head together with cost involved :—

Table II : Cost analysis of road transportation

Sector	Loading Point	Average lead in miles	Average ton mile cost in Rs.	Total cost per ton in Rs.
1. Barajamda-Barabil Sector, Orissa.	Barbil, Barajamda.	15	0·75	11·25
2. Siljora-Kalimati Sector, Orissa.	Banspani.	15	0·75	11·25
3. Sarkunda-Bhutra Sector .	Barbil.	38	0·75	28·50
4. Sanguem Sector . .	Saverdeom.	20	0·50	10·00
5. Dandeli, Supa, Castle Rock.	Londa, Castle Rock, Tinaighat.	18	0·70	12·60
6. Chipurupalli Garbham Sector, A. P.	Chipurupalli, Garbham.	5	—	A few rupees

Sector	Loading Point	Average lead in miles	Average ton mile cost in Rs.	Total cost per ton in Rs.
7. Chindwara, Nagpur, Bhandara, Balaghat Sectors.	Tirodi, Balaghat Kutingi, Seongi, Ramtek. (There are sidings at the mines of MOIL and CPMO).	15	Reportedly very high as much as Rs. 2·00 ton mile.	30·00
8. Sandur Sector	Samihalli, Yeshwant Nagar.		Aerial Rope-way. No road transportation.	
9. Shivrajpur Sector . .	Railway siding at the mines.			

It will be seen from the above table that in Orissa, average road transportation cost per ton of ore is about Rs. 15.00 for an average lead of about 20 miles. In Mysore for an average lead of 18 miles the cost comes to about Rs. 13.00 per ton. In Madhya Pradesh and Maharashtra, except Manganese Ore India Ltd. and Central Provinces Manganese Ore Ltd., which have the advantages of railway sidings located near the mines, the road transport cost is about Rs. 30.00 per ton. The Andhra deposits are nearer to railway loading points and for this reason road transport costs are comparatively low.

The cost elements which enter into the business of road haulers are (i) owning cost comprising depreciation, interest etc., (ii) operational cost comprising P.O.L., drivers and helpers wages etc., (iii) maintenance, repairs, and up-keep cost, (iv) miscellaneous costs comprising taxes, profits etc. Improvements in the condition of roads generally leads to reduction in maintenance charges. The fact of the situation in India, however, is that the mining areas have the poorest roads and consequently highest maintenance costs of road transport. Frequent break-down of vehicles coupled with lack of repair facilities and paucity of supplies of spare parts is responsible for costly operational hold up and delay. Expenditure on fuel obviously is a very important element of cost. Average fuel consumption per mile over Indian roads is, perhaps, the highest. Then there are such stationery items of expenses on licensing fees, road taxes etc. The net effect of these various factors is that the transport companies are reluctant to operate in mining areas and

there are not enough trucks to carry ores. In the circumstances the ton-mile cost for transport of manganese as also for other ores is extremely high.

It is recognised all over the world that road transport is the costliest means of transport for carrying ores which are to be sold at competitive prices. But the unfortunate fact in India is that manganese mines in the country are small mines dispersed over different areas in respect of which the only link available is road transport. The remedy may lie in increasing the capacity of the trucks and making use of conventional rear discharge trucks/dumpers which would considerably reduce the cost of transport. These adaptations would, however, involve sizeable addition to capital costs, which only large transport companies could afford. Small mining units which of necessity have to depend upon the capacity of existing trucks, can expect some relief only from improvement in conditions of approach roads and other roads in their areas.

It is hardly possible for this Committee to examine all aspects of road problems in mining areas. However, it may be emphasised that mining areas of India need immediate attention. The export drive would fail if conditions favourable to low production cost are not created. Some of the State Govts. such as Bihar & Orissa have undertaken construction of roads to open up and link the important mineralised zones and working mines with the railway system and the ports. This process should be intensified in all mineral bearing areas. It may be borne in mind that the new roads should be constructed particulary to cope with heavy traffic. The present light trucks would have to give place progressively to heavy diesels. During the course of study tour of Orissa mining areas the Committee inspected the Joda-Dubna road which was then under construction and it was found that this road was not very suitable for heavy ore traffic. The Committee have already brought this to the notice of the State Government.

Apart from the need of constructing new roads, it will be essential to improve the existing roads in mining areas. This deserves immediate attention of the State Government. The Committee, during their tour of Mysore State made a recommendation to the State Government for the repairs of Joida-Diggi road and construction of 8 miles road to connect it to the road on the Goa side.

The Planning Commission is studying requirements of roads in mining areas and based on this study separate allocation of funds are likely to be made for mining sector during the Fourth Five Year Plan. The Committee is of the view that the Planning Commission should consider utilisation of funds at their disposal in consultation with the State Governments and Ministry of Steel & Mines for construction of new roads as also repairs and improvement of old roads, with particular reference to movement of manganese ore in various areas.

The Minerals & Metals Trading Corporation of India Ltd. could also be provided with funds by the Government for giving grants for the specific purpose of construction of roads in selected mining areas in consultation with the Ministry of Steel & Mines.

Construction of access roads to individual mine or group of mines is obviously important. The development of such feeder roads upto a distance of 5 miles from the mines would have to be the responsibility of the individual mine-owner or the group of mine owners who stand to benefit from these roads.

(b) *Rail.*—As a rule, rail transport accounts for a major portion of total transportation cost from the mine to the port or the consuming markets within the country. The majority of manganese mines are situated at relatively long distances from the ports of export.

The table below gives an over-all picture of rail transportation costs in India.

Table III : Analysis of rail transportation costs.

Production Sector	Loading point	Port of discharge	Average distance in Kms.	Average freight/ton in Rs.
1. Shivrajpur, Gujrat	Shivrajpur Siding.	Bombay	458	17·20
2. Sandur, Mysore	Samihalli, Yeshwantnagar.	Bombay	880	22·90
3. Sandur, Mysore	Samihalli, Yeshwantnagar.	Madras	597	18·50
4. Sandur, Mysore	Samihalli, Yeshwantnagar	Visakhapatnam.	961	24·40
5. Sandur, Mysore	Samihalli, Yeshwantnagar.	Marmugao	423	16·80
6. Dandeli, Supa and Castle-rock, Mysore.	Tinaighat, Londa, Castle-rock.	Bombay	600	18·90
7. Sanguem	Colem	Marmugao	60	11·44 (includes Rs. 6·40 wharf due).
8. Srikakulam, Andhra Pradesh.	Chipurupalli.	Visakhapatnam.	100	8·80
9. Chindwara, Bhandara, Balaghat Sector.	Tirodi, Balaghat, Kuttingi, Ramtek, Saongi.	Bombay	600	18·90 Average
10. Chindwara, Bhandara, Balaghat, Sector.	Tirodi, Balaghat, Kuttingi, Ramtek, Saongi.	Vishakhapatnam.	600	18·90 Average
11. Barajamda Barbil Sector, Orissa.	Barbil, Barajamda	Calcutta	392	15·90
12. SHjora-Kalimati Sector, Orissa.	Banspani	Calcutta	446	17·20
13. Sarkunda-Bhutra Sector.	Barbil	Calcutta	392	15·90

The incidence of railway freight on industry has been a subject of considerable controversy between the representatives of industry and the railway authorities.

The representatives of industry have held the view that the railway freight has steadily registered a disproportionate increase. On the other land the railways contend that the rise has been due to a general rise in basic costs and that the present rates barely cover the operational costs.

The Committee has noticed that there have been frequent changes in the freight rates on manganese ore during recent years. From 1st October, 1958 manganese ore was brought under railway tariff classification 40A from classification 32.5A, which meant an increase in the railway freight amounting to about 23%. As a result of various representations made to the Railway Board by the mining interests regarding the difficulties in selling ore, the Railway Board examined the matter at some length and announced a rebate scheme from the middle of 1959 under which low grade ore was allowed a freight concession of about 18¾% and medium grade ore of about 12½% for movement beyond 200 miles. No concession on high grade ore was allowed. Later, during 1961 further representations were received by the Railway Board for higher rate of concession for all grades of ores in view of the deteriorating position of the Indian manganese ore in the world market. These rates were, therefore, further reduced from 1st January, 1962 for a period of one year. The revised rates are given in Table-IV. It will be seen that these concessional rates, so far as they related to distances over 500 km, were somewhat lower than the rates charged for coal traffic, which the Railway Board consider barely cover the cost of transportation. In view of this the Railway Board made an upward revision of the rates from 1st April, 1963. These rates are now in force and have been listed in column 4 of Table IV.

The Committee is of the view that frequent changes in freight rate have subjected manganese industry to unforeseen additional strains. As manganese is a sensitive commodity in the world market, these frequent changes must be avoided, as far as possible. Although the present concessional rates are considered somewhat excessive and do not satisfy certain sections of the industry, the Committee recommends, as a compromise, that there should be no increase beyond the level of current rates (as effective from 1-4-1963) for another five years from now.

TABLE IV : Freight structure (Per tonne)

Distance in km.	Present Tariff rate inclusive of surcharge	Concessional rate in force upto 31-3-63	Concessional rate effective from 1st April, 1963
	Rs.	Rs.	Rs.
100	9·90	7·80	8·80
200	14·40	11·90	12·90
300	18·50	14·00	15·00
400	22·40	14·00	16·00
500	26·20	14·00	17·20
600	29·50	14·00	18·90
700	32·70	14·10	20·40
800	36·10	15·60	21·70
900	38·90	16·85	23·30
1000	41·60	18·05	24·60

The Committee would like to urge that even in the matter of allotment and placement of wagons the railways should bear in mind the special requirements of manganese mining industry. For example, unlike in case of iron ore, it is not possible to ensure movement of ores in rake of box wagons. It is not unusual for a producing unit to work a number of mines each producing manganese ore of different grades. It is only by judicious blending of ores of different grades drawn from different mine that an intelligent producer manages to evolve an economic marketable grade. Thus in keeping with the needs of the composition of the required blend, one of the several mines may be required to despatch more wagons than others. It is also necessary that wagons are made available at number of despatch sidings simultaneously over the same period of time so that the constituent ores are moved to and become available at the final destination *i.e.* the port where eventual marketable blend is produced. It is understandable that on certain occasions it may not be possible to meet the full requirements of wagons indented by a producer. In such cases in view of the exigencies of blending operation it will be desirable to make a proportional reduction in number of wagons indented for each particular siding serving the concerned mine. It has been mentioned that there have been occasions when Railways place block rake of wagons on one or two sidings only without regard to the fact that more wagons could be allotted for other sidings from which ore had also to be moved. Obviously this situation arose because the Railways operation staff were not fully conversant with the peculiar needs of manganese ore industry. Committee recommends that as far as possible the indents for wagons required for movement of manganese ore particularly from important mines which produce ores for export should be carefully scrutinised with reference to the special requirements of the producers marketing the end product at the port.

Then again the routine insistance of the railways authorities on the use of rakes at port sidings poses a serious problem. The stacking space frontage available to single exporter in the port area is extremely limited. It is not always possible to accommodate a full rake for unloading alongside this limited frontage. And wherever in spite of this difficulty ore has to be moved in a full rake, the blending of ores becomes a difficult operation. The Committee strongly recommends that in view of India's stake in the manganese export market, there is a strong case for allotment of four wheelers even at the cost of some inconvenience to the Railways.

The Committee found that at number of loading stations such as Barajamda, Barbil and Banspani separate sidings are not provided for manganese ore. As far as possible seperate sidings should be provided for these as well as other important loading stations.

Another amenity which the railways might provide as far as possible is weighment facilities at loading points.

(c) *Aerial Rope-ways.*—Rope-ways are used for the transportation of ore from Ukwa mine belonging to Manganese Ore (India)

Ltd. to Bharweli siding, a distance of about 18 miles and from Ramdungri mine to Gumgaon mine, a distance of about a mile. The cost of transportation at present is reported to be low mainly because the rope-ways were installed along time back and since then the capital costs have been fully depreciated. There are two rope-ways at Sandur mines of M/s. Sandur Manganese and Iron Ores (P) Ltd. of 8,000 ft. and 10,000 ft. length each. These carry ores to Samihalli and Yeshwantnagar sidings in buckets of 0.4 ton capacity each. There are no other rope-way systems in India for the transportation of manganese ore.

(d) *Inland Water Ways.*—Generally manganese ore and iron ore in Goa are transported from the mines to the jetties by road and thereafter it is moved by barges to the port for midstream loading. Most of the producing companies have their own fleet of barges and the expenses incurred per ton of ore moved are nominal as compared to rail transport costs.

Ports.—In India manganese ore is exported through Vishakhapatnam, Calcutta, Bombay, Madras, Murmugao, Karwar and Coondapur ports. More than fifty per cent of the total exports are channelled through the Vishakhapatnam port.

Port charges.—The port charges average about Rs. 10 per ton in India as compared to $1.00 a ton at most of the ports in other countries.

Impact of loading rates on Ocean freight.

The loading rates at the Indian ports for manganese average about 600 tons per day as against the loading rates of 2,000 tons per hour at port Macapa, Brazil and 4,000 tons per day at port Elizabath, South Africa. Production from Gabon is shipped through the Atlantic Ocean port of Point Noire where automatic loading facilities have been provided. Ghana ores are exported through the port of Takoradi which reportedly has excellent mechanical facilities for handling limited traffic.

The slow loading rate at the Indian ports results in abnormally slow turn round of vessels which leads to higher waiting charges and consequently enhanced ocean freight. In reply to the Committee's questionnaire, M/s. Sandur Manganese and Iron Ore (P) Ltd. were good enough to send together with other useful information a copy of the letter dated 27-9-63 addressed by M/s. C. M. Los (London) Ltd. to their shipping agents, M/s. Gordon Woodroffe & Co. (Madras) Private Ltd., on the subject of port facilities in India. The Committee considers it desirable to reproduce the following extract from this letter which felicitously describes Indian conditions and their bearing on freight and consequent effect on the general competitive position of Indian commodities in the world market.

"Commensurate with increase of speed, obviously cargoes will be out-turned in better condition from this type of vessel, owing to the much decreased time spent at sea and generally speaking Port Authorities, have, of course, also collaborated in Shipowners' modern outlook by arranging to handle vessels faster in loading and discharging operations. The net

result is, of course, that many countries are today having their bulk commodities of import and export carried more economically and in better condition than previously. So far as India is concerned, things seem to be progressively worsening. The overall time spent by modern vessels on ocean passages, plus the time spent loading and discharging in Indian ports is now resulting in the overall time spent on a voyage to or from India becoming the same as it used to be in the days of the old 10 knot burners. In other words, owners; contribution to more modern economical conditions is being completely nullified in the case of Indian ports, and it is obvious that this state of affairs cannot continue, which will, of course, either mean that Indian cargoes will only secure the old type of un-economical slow vessels, or alternatively that India will have to face freight rates which will be higher than the level one would anticipate at current freight market rates".

It is the considered view of the Committee that berthing of vessels and ore handling facilities at the Indian ports dealing with manganese export should be substantially improved so that a ship could be loaded in maximum of two days. Some suggestions for improving the existing facilities in various ports have been given in the following paragraphs. But the Committee feels that this is a problem which needs a thorough technical study by experts which the port autorities alone are competent to undertake. Plans for modernisation of loading facilities and berthing of large carriers are already under discussion in relation to particular commodities such as iron ore. The Committee recommends that the needs of manganese ore should also be kept in view when such plans are drawn up and implemented.

At persent manganese ore is exported from India in liner of about 10,000 tons capacity against charters of 30,000 tons in other countries. The ocean freight rates with 30,000 tons ore carriers are substantially lower than those for 10,000 tons ore carriers. The buyers of ore are primarily interested in the lower cost of the ore landed at their furnace. In the study of cost structure of exported ores, it is important to take into account the element of ocean freight and devise all possible means to reduce this element if Indian manganese ore is to retain its place in the international market. Sooner or later, the buyers would reject or be reluctant to accept ores which are delivered to them at higher costs mainly because of the higher ocean freight. The fact of the present situation in India is that there is hardly any port which can handle 30,000 tons ore carriers. However, a few of these ports are in the process of being modernised and developed and may in due course be able to accommodate large ore carriers. It is suggested that when that development materialises, manganese ore should be exported in larger carriers of 20,000 tons to 30,000 tons or more. It will then be possible to achieve further economies by bulk loading of these carriers.

A brief description of conditions prevailing at the important ports in India is given below :—

(*i*) *Visakhapatnam Port.*—The total stacking space for manganese ore available at the port can hold 3 lakh tonnes of manganese ore. Out

of this, one lakh tonne stacking space is exclusively meant for Minerals & Metals Trading Corporation of India Ltd. for iron ore. There are two separate berths for manganese which are located about a mile from the dumps. The loading is done semi-mechanically through skips of 2 tonnes capacity each. The loading rate is about 1,500 tonnes per day. About 5 to 6 lakh tonnes of manganese ore are exported annually at present. The Committee, during their tour of the port, noted that the existing dumping facilities for manganese ore were quite inadequate even for the present level of export trade in manganese.

The other important point which came to the notice of the Committee was the difficulty experienced by exporters in transporting ore in rake of box wagons. This problem has already been referred to in the discussions relating to rail transportation.

Port charges at Visakhapatnam

Manganese ore shipment	Cost per tonne (in Rs.)
(a) Wagon unloading charges (appx.)	0·96
(b) Plot rent	0·13
(c) Shipping charges	3·00
(d) Handling charges	1·00
(e) Gear charges	0·30
(f) Wages of Supervisors & tally clerks	0·13
(g) Commission	0·37
(h) Sundary charges	0·17
(i) FOB to FOBT	0·45
Total	6·51
or	6·50

There is uniform skip rate of Rs. 2.00 per skip both for high grade and low grade ore. There is a case for a separate slab for low grade ore.

(*ii*) *Madras Port.*—Madras has at present to deal with 60,000 tons of manganese ore traffic. The stacking space for manganese is adequate and is located about a mile from the loading berth. There is no separate berth for loading manganese ore. Loading rate is low, about 600 tons per day. Although the present ore traffic is small, the port was handling an average of about 150,000 tons per annum in the past. The Committee is of the view that with the improvement of conditions at the port, more traffic may be expected. The Committee recommends that the berth South Quay III may be used for manganese ore. Stacking space of about 10,000 tons is available at the key of the basin. But normally the vessels should be fed from the present manganese depot which is about a mile away. Only in the event of ore not being available from the main stack the dump at the key of the basin should be drawn upon.

The question of connecting the new basin with manganese ore depot was discussed by the Committee with the port officials and many suggestions were put forth, by the members of the Committee as well as the port officials, such as the installation of conveyor belt or provision of lorries. There was a general agreement that it will be advantageous to bring the ore from manganese depot on trollies with flat tubs.

It was mentioned by the Port officials that as soon as iron ore programme was completed, scoda cranes would be available. Shift-derricks would also be provided and work could be started as soon as the basin was ready. The Committee recommends the speedy implementation of these programmes.

The Committee is confident that a loading rate of 3,000 tons/day can be achieved at Madras Port if the above suggestions are implemented.

Port charges at Madras

	(In Rs./tonne)
(a) Wagon charges	0·75
(b) Haulage charges	0·65
(c) Loading and unloading (4 operations)	7·00
(d) Weighment charges	0·12
(e) Harbour dues and wharf cleaning charges	1·83
(f) Supervision charges	0·12
(g) Commission	0·50
	10·92
FOB to FOBT	3·75
Total	14·67

Port charges are high. But this is mainly due to the incidence of labour costs. The port authoritieis expressed their inability to effect any reduction in the port charges because the handling of ore including the loading and unloading operation is carried out through the agency of the employer's association who are responsible for negotiating the wage structure and service conditions of the workers. The Committee, however, feels that there is a scope for reducing labour costs to the extent that costs are inflated by reasons of idle labour hours. For example, it should be possible to eliminate idle labour time by carefully co-ordinating the programmes of placements of wagons with the operation of loading of ore in the ship-holds.

(*iii*) *Calcutta Port.*—The shipment of manganese ore from Calcutta port has declined from a figure of 307,515 tons in 1955 to nearly 25%, *i.e.* 87,411 tons in 1963 owing to slump in the trade. There is no separate berth for loading manganese ore at the port. The loading rate is about 700 tons per day for charters and 500 tons per day for liners. Calcutta port suffers from serious limitations due to tidal waves. The port officials informed the committee that if proper co-ordination were maintained, loading of the ships could be planned efficiently. Information regarding the sailing dates, the quantity to be loaded and the type of ships requisitioned should be made available to the port officials well in advance. The railways should provide 4 wheelers instead of box-wagons.

The stacking depot for manganese ore is situated in close proximity to the stacking space for other minerals like iron ore and the chances of contamination are serious. Ore should be so stacked as to avoid any such contamination.

Port charges at Calcutta.

Comparative Study of Port Charges for Shipment of Manganese Ore at various Berths at Calcutta Port

Particulars of the port charges	Mode of shipment			
	Shipment Ex-dump via transit shed 56 T. box wagons.	Shipment Ex-dump via transit shed. 4 wheeler 22 T.	Shipment Ex-transit shed direct. 56 T. box wagons.	Shipment Ex-transit shed direct 4 wheeler 22 T.
1	2	3	4	5
1. OA Diversion	x	x	Rs. 5·00 S/C Rs. 1·67 Rs. 6·67 Rs. 0·12 per tonne.	Rs. 2·50 S/C Rs. 0·84 or Rs. 3·34 Rs. 0·15 per tonne.
2. Terminal charges 6 pies per Md. or 0·85 Paise per tonne plus surcharge.	Rs. 47·60 S/C 12½% 6·00 Rs. 53·60 Or Rs. 0·96 per tonne.	Rs. 21·7 or Rs. 0·96 per tonne.	Rs. 53·60	Rs. 18·70 S/C 12½% 2·37 Rs. 21·07 per tonne.
3. Local Haulage charge Rs. 1·60 Paise per tonne.	Rs. 89·60 Or Rs. 0·96 per tonne.	Rs. 35·20	Rs. 89·60	Rs. 35·20
4. Siding charges Rs. 2·50 per axle plus 20% surcharge	Rs. 18·00 per box wagon. Or Rs. 0·32 per tonne.	Rs. 5·00 Rs. 1·00 Rs. 6·00 Or Rs. 0·27 per tonne.	x	x
5. P.T.R. charges Rs. 2·46 Paise per tonne	Rs. 137·76 less Rs. 15·68 Rs. 122·08 S/C Rs. 40·69 Rs. 162·77 Or Rs. 2·91 per tonne.	Rs. 54·12 less Rs. 6·16 Rs. 47·96 Rs. 15·99 Rs. 63·95 Or Rs. 2·91 per tonne.	x	x
6. River dues Rs. 1·48 per tonne plus 50% surcharge.	Rs. 82·88 Rs. 41·44 Rs. 124·32 or Rs. 2·22 per tonne.	Rs. 48·84 Or Rs. 2·22 per tonne.	Rs. 124·32 Or Rs. 2·22 per tonne.	Rs. 32·56 S/C Rs. 16·28 Rs. 48·84 Or Rs. 2·22 per tonne.
7. Shipment charge Rs. 1·97 per tonne plus 33·1/3% surcharge.	Rs. 110·32 S/C Rs. 36·78 Rs. 147·10 or Rs. 2·63 per tonne	Rs. 57·79 Or Rs. 2·63 per tonne	Rs. 147·10 Or Rs. 2·63 per tonne	Rs. 43·34 S/C Rs. 14·45 Rs. 57·79 or Rs. 2·63 per tonne
8. P.C. Labour charges Rs. 0·60 per tonne.	x	x	Rs. 33·60	Rs. 13·20
9. Spl. charge 0·25 per tonne for box wagon.	Rs. 14·00	x	Rs. 14·00	x
10. Weighment charge per tonne x Rs. 0.53.	Rs. 29·68	Rs. 11·66	x	x
11. Total	Rs. 639·07	Rs. 244·51	Rs. 468·89	Rs. 179·44
12. Cost per tonne	Rs. 11·41	Rs. 11·11	Rs. 8·37	Rs. 8·16
13. Remarks	Element of rent unloading and loading cost at party's dump not included.	Element of rent loading and unloading cost at party's dump not included.	No facility for shipment of manganese ore in Box wagons available at present.	

(*iv*) *Bombay Port.*—Bombay port presently handles a traffic of nearly one lakh ton of manganese ore per year. The loading rate is about 600 tons per day. Since Visakhapatnam port is being geared largely for iron ore export, Bombay is likely to emerge as important outlet for manganese ore. It is necessary that mechanical facilities should be installed at this port for manganese.

Shifting of vessels from one berth to the other for loading at more than one berth, depending on draft is at present an inseperable necessity, but none the less a time consuming process. The Committee hopes that the programme of modernisation which will necessarily include dredging of relatively shallow depths will help to accommodate larger ore carriers or loading of the present vessels to deeper drafts.

The condition of the Bombay Port Trust Railways is far from satisfactory. Certain recommendations were made by the Committee to the Chairman Port Trust for implementation. A brief resume of the progress follows.--

Procurement of additional KL type wagons by the Port Trust Railways:

The Committee had suggested to the Port Trust authorities that very early steps should be taken to replace the existing wagons of the Trust Railways, most of which were in an advanced stage of dilapidation, by at least 100 KL type wagons to be procured from the Railways. It is understood that the Trust has taken up the matter with the concerned authorities for the supply of 50 wagons and it has been decided to recondition another 50 wagons. The Committee recommends that this programme of replacement and renovation should be expedited.

Tractor shovel loading into wagons:

It has been suggested by the Committee that to reduce the labour costs as far as possible tractor shovel loading should be adopted instead of manual loading. The Port Trust should acquire an adequate number of shovels and utilise these for loading the ore into the wagons on payment of a reasonable charge by handling agents. It is understood from the Port Trust that the technical advice is to the effect that loading by the tractor shovel would result in damage to the wagons. In that case grab fitted mobile cranes should be used for loading & unloading of wagons.

Transportation of ore from manganese depot to berths exclusively by wagons:

The Committee had made a suggestion that transportation of ore from the manganese ore depot should be done by wagons only as road transportation would increase the cost by approximately Rs. 2.00 per tonne.

It is understood from port authorities that while they are taking the requisite action to provide maximum number of wagons, it is difficult for them to agree to the suggestion that transportation from the depot should be done exclusively by wagons. In fact the view of the port authorities in this matter is if all movement of ore from the depot

could be arranged by road, there would be substantial counterbalancing advantages. First a loading rate of 2,000 tons per day would be achieved using five hooks and two winches. Secondly more despatch money could be earned by saving idle time. If the manganese trade would agree to all movement of ore form the depot by means of trucks, the port authorities would be prepared to provide a modern cement concrete road to carry the traffic.

The Committee does not favour the change to road transport in the present depressed market conditions.

Rectification of defects in the weighbridge:

It was represented that the weigh bridge provided by the Port Trust did not register accurate weighments. The Committee recommends that either two weighbridges should be maintained to provide facilities for cross check, alternatively an automatic recorder be installed at the existing weight bridge, or a weighbridge with punch-card system may be provided.

Port charges

	(in Rs./ton)
(i) Unloading charges	0·69
(ii) Siding charges	0·14
(iii) Loading charges	0·75
(iv) Wharfage charges	1·65
(v) Wagon booking charges to dock	1.50
(vi) Weighment	0·10
(vii) Agency Commission	0·75
(viii) Sundry charges	0·25
Total	5·83
FOB to FOBT	6·00
Total	11·83

(*v*) *Marmugao Port.*—Marmugao is a natural harbour equipped with mechanical loading facilities on a large scale, but all such facilities are related to iron ore exports. Manganese ore exports from this port are very much limited. The following are the shipment statistics.

	1961-62	1962-63
	(In tons)	
Ferruginous ore (locally known as Ferro-manganese ore)	89 957	72,896
Manganese ore	34,784	13,100

At present ferromanganese ore and manganese ore are loaded in ships by barges as well as railway wagons. The loading rate by barges is about 2,000 tons per day whereas by railway wagons it approximates to 500 tons per day. The condition of harbour wagons is good. Marshalling of wagons is smooth. With proper co-ordination 90 wagons could be loaded in 8 hours shift.

The Committee is of the view that Marmugao port can handle larger quantities of manganese ore by a combination of wagons and barges. Low grades ore of North Kanara, Mysore and also Sandur ores may be exported through this port. Necessary facilities may be provided for this.

Port charges

	(In Rs./tonne)
(a) Unloading charges	0·87 to 1·12
(b) Loading charges	0·87 to 1·12
(c) Wharfage dues	6·40
(d) Agency commission	0·36
(e) Customs duty	Nil
(f) Cargc dues	0·05
(g) Other expenses	0·45
(h) FOB to FOBT	2·50
Total	11·50

6.07 Conclusions

(1) The cost of transportation has always been regarded as one of the major factors in the F.O.B. cost which determines the competitive position of Indian minerals in foreign markets. In other manganese ore producing countries of the world such as Russia, Brazil, Gabon, Union of South Africa and Ghana, great advance has been made in the development of transport facilities.

(2) For transporting ore from the mines to the railhead, aerial rope-ways are used on an extensive scale. For example, the mining areas of Chiature (Georgia, Russia) are serviced by an aerial tramway to a 21 mile spur of the main line of the Trans-Caucasus railways. In Gabon, a 45 mile cable-way with a capacity of 850,000 tons a year has been built to carry the ore from the mines near-France-ville to rail head at 'M' Binde. In India rope -ways have been used to a very limited extent. M/s. Manganese Ore India Ltd., are operating two ropeways from their Ukwa mine to Bharweli siding, a distance of 18 miles and from Ramdungri mine to Gumgaon mine, a distance of about a mile. M/s. Sandur Manganese and Iron Ores (P) Ltd. have two ropeways 8,000 ft. and 10,000 ft. each at their Sandur mines, Mysore. The rest of the producers have to transport ore by road to the rail-head Only one or two large firms have railway sidings near the mines. The average ton-mile cost of road transportation is Rs. 0.75.

(3) In almost all manganese producing countries, ore is transported by rail to the ports for export. In Brazil a railway line of more than 200 km. has been constructed from the Amapa mines to the Porto Macapa. In Gabon a 180 mile rail road has been built from 'M' Binda to a junction point near Dolisie on the Congo Ocean rail-road which runs into Atlantic port of Pointnoire. In Russia Trans-Caucasus Railways carry ores from Chiature area to Betum (126 miles) or Poti (90 miles) on the Black Sea. Ghana ores are transported on Sekondi-Kumasi railway line to Tekoradi port, a distance of 39 miles. There have been innovations in the use of rail equipments for the handling and carriage of ores. At Amapa, Brazil the washed ore is drawn from the bottom of 550 tons ore bins into rail-road cars on a single loading track under the bins which is designed with a slight grade permitting an entire ore train to be loaded and assembled by gravity with no locomotive required. A 70 tons car can be loaded in one minute. The ore reaches the port in 70 tons bottom dump cars.

The expenditure on transportation of ore from mine to the port is not a major factor of cost in other countries. The rail-haul is comparatively short. In India, excepting in Andhra Pradesh and Goa, ore has to cover an average distance of more than 400 kms. before it is shipped from the port. Similarly the freight cost per ton of ore is in the neighbourhood of Rs. 18·00.

(4) Steady increase in the size of vessels is bringing about a marked reduction in the ocean freight on shipments of ore. Improved facilities for handling cargo are another factor which have a beneficial effect on the competitive position of minerals in the world market.

In India port charges generally approximate to Rs. 10·00 per ton as compared to \$1·00 a ton at most of the ports in other countries. The loading rate at the Indian ports is in the neighbourhood of 600 tons per day as against the loading rate of 2,000 tons per hour at Porto Macapa, Brazil and 4,000 tons per day at port Elizabeth, South Africa. Production from Gabon is shipped through the Atlantic Ocean port of Point Noire where automatic loading facilities have been installed. Ghana ores are exported through the port of Tekoradi which has excellent mechanical facilities for handling limited traffic. The slow loading rate at the Indian ports results in abnormally slow turn around of vessels which makes for less favourable freight terms.

6.08 Recommendations

(a) *Road Transport :*

1. In India, mining areas are served by very poor roads and this is responsible for high maintenance charges and fuel consumption of transport vehicles. The Committee recommends that intensive road construction or road improvement programmes for mining areas should be undertaken. As far as possible new roads should be built to cope with heavy traffic. More and more the present light trucks would have to give place to heavy diesels. During the study tour of Orissa mining areas the Committee inspected Joda-Dubna Road under construction by the

State Government and it was found that this road was not very suitable for heavy ore traffic. The matter has already been brought to the notice of the State Government. It may be desirable for the Central Government to ask the State Governments to particularly bear in mind the needs of heavy load traffic when they implement their road programmes.

2. Apart from the construction of new roads, it would be essential to modernise existing roads in mining areas. Attention of the State Governments may be drawn to this aspect. During their tour of Mysore State, the Committee had an opportunity to recommend to the State Government the importance of the repairs of Joida-Diggi road and construction of an additional 8 miles road-link to the road on Goa side in order to provide an outlet for Mysore Region (North Kanara) low grade ore through Goa. The Committee hopes that the State Government would find it possible to accept and implement the suggestion. Similarly, there is a strong case for modernising the existing track between Sarkunda area and newly opened railway station at Barsua in Orissa state for manganese ore traffic in Orissa.

3. The Committee is of the view that the Planning Commission should utilise funds at their disposal in consultation with the State Governments and the Ministry of Steel & Mines for construction of new roads, as also for repairs to and modernisation of the old roads for movement of manganese in various areas.

4. The Minerals and Metals Trading Corporation of India should be provided with certain funds by Government for giving grants to mine owners, or for the construction of new roads and modernisation of the existing roads in the mining areas in consultation with the Ministry of Steel and Mines.

5. Apart from the construction of the main roads in the mining areas as outlined above, attention may also be given to the construction of access roads to individual mines or groups of mines. The development of such feeder roads upto a distance of 5 miles m the mines should be the responsibility of the individual mine owner or oups of mine owners, who will be the principal beneficiaries.

(b) *Rail Transport* :

1. The incidence of railway freight has been a subject of some controversy between the representatives of the industry and the railway authorities. The former are of the view that the railway freight has steadily registered a disproportionate increase, but the latter have contended that this is the result of a general rise in basic costs and that the present rates barely meet operational expenditure.

2. The Committee is of the view that frequent changes in freight rates have subjected manganese industry to unforeseen additional strains. As manganese is a sensitive commodity in the world market, these frequent changes must be avoided in future as far as possible. Although the present concessional rates are considered some what excessive and do not

satisfy certain sections of the industry, the Committee recommends, as a compromise that there should be no increase beyond the level of the current rate (as effective from 1-4-1963) for another 5 years from now.

3. The Committee is of the view that the railways have to keep in view the special requirements of industry in the matter of allotment of wagons or enforcing the rule for the movement of ore in a rake of box wagons, for the reasons already explained in this chapter.

The supply of wagons should be made with reference to the need of each separate loading point as per the indent of the producer to enable him to take his ore at the port in requisite proportion from different mines for producing a final blend at the port.

The use of rake of box wagon is desirable, but in effect not workable because at the port, the stacking space frontage available to individual parties is limited, and un-loading from full rake is subject to serious physical difficulties, which will affect both the cost and quality of the end product i.e., the exportable ore. The Committee recommends that, depending on the merit of the case, four wheelers may be allowed for manganese ore movement.

4. Separate sidings should be constructed for manganese ore at all the important loading points and weighment facilities should be provided.

(c) *Rope-ways* :

Ropeways are relatively economical modes of transport. Suitable surveys should be carried out in selected mining areas for installation of ropeways systems.

(d) *Ocean Transport* :

1. It is the considered view of the Committee that facilities at the ports should be improved so as to achieve a normal loading rate of atleast 4,000 tons per day. The Committee feels that the port authorities are in a better position to plan necessary improvements. Plans for modernisation of loading facilities and berthing of large carriers are already under discussion in relation to particular commodities, such as iron ore. The Committee recommends that the needs of manganese ore should also be kept in view when such plans are drawn up and implemented.

2. At present manganese ore is generally exported in liners of about 10,000 tons capacity as against charters of 30,000 tons capacity in other countries. The rates of liners are much higher as compared to charters. There would be appreciable reduction in c.i.f. cost if manganese ore is exported in charters of 20,000 tons capacity. Interest of manganese trade has suffered partly due to a multiplicity of exporters selling small packages in different markets. Now that Government of India have taken a decision to canalise all trade of manganese through two public sector agencies *i.e.*, Minerals and Metals Trading Corporation of India Ltd. and the Manganese Ore India Ltd., it should be possible to secure better prices for Indian manganese ore through a co-ordinated operation in both the traditional and new markets. It should also be possible to achieve economies of large charters.

3. There is no room for any increase in port charges.

Port-wise recommendations;

Recommendations for improvement of the existing facilities in various ports will be found in the discussions relating to the ports (Paras. 6·06(e), (i), (ii), (iii), (iv) and (v).

BIBLIOGRAPHY

(1) Field reports of the Committee on manganese ore.

(2) Know-how Conquers Jungle—A Brizilian publication.

(3) Brizilian Business—May 1963. Vol. XLIII No. 5

(4) The Gabon Republic, February, 1961.

(5) Mineral Resources of South Africa.

(6) Transportation in Canada, Mineral Resources Division, Department of Mines and Technical Surveys, Canada.

सत्यमेव जयते

CHAPTER VII

MINING, MINES MANAGEMENT AND MINE FINANCING

7.00. Manganese mining operations in various parts of the world cover a wide range from primitive methods of quarrying to modern sophisticated mining techniques. However, the major portion of world's manganese ore production is still derived from open pits or shallow underground workings.

Owing to marked differences in the patterns of occurances of manganese deposits in different areas, a wide variety of mining methods is adopted in various parts of the world.

Details of the techniques current in various countries are not available. However, broadly speaking, underground mining is practised in U.S.S.R., U.S.A., Chile, Morocco, Cuba and besides, in a few places also in India. Open-pit mining is the rule in majority of mines in India, South Africa, Brazil and Congo.

A brief resume of mining techniques in use in some of the manganese producing countries is given below :—

7.01 **Union of Soviet Socialist Republics**

The long wall retreating method of mining is understood to be in use at both Nikopol and Chiature deposits where ore occurs as flat lying beds. Under this the area to be served by shaft or adit is first developed to its outer boundaries by haulage ways. Mining begins at these outer limits and the bed is completely removed progressively back towards the shaft or portal. Roofs are supported by timbering near the face. At Nikopal manganese beds lie 50′ to 100′ below the surface. At Chiature the bed averages 6′-7′ in thickness and outcrops on steep hill sides and is entered by adits. The ore is drilled by electric augurs. Mechanisation is reported to be well advanced.

7.02 **Brazil**

The Amapa deposits are worked by Industria O Commercio de Minerios, S.A. (ICOMI) in which Brazilian group have retained 51% of the stock, and the rest is held by the Bethelhem Steel Company of the U.S.A. The mine, designed for an annual production of 600,000 tons of ore, may be increased to 1,000,000 tons by addition of more equipment. Development cost of the property, advanced by the Export Import Bank was nearly $5,000,000. This finance was needed to instal the mine, build a 200 km. rail-road and construct an Amazon River Port. Exports from the mine started in 1957. It is reported that the loan was completely repaid five and a half years after ICOMI began production.

Two of the most southerly ore-bodies, designated as T-4 and T-6 are being worked at present. After stripping the overburden which varies considerably in depths and character, the ore is mined in 25 ft. benches

by standard open-pit methods. All known ore is equally accessible. Pneumatic wagon drills and jack hammers with tungsten-carbide insert detachable bits are used in drilling. Compressed air for the drills is supplied by portable compressors. Blasting is done by conventional methods.

7.03 **Gabon**

A notable event in the African mining history was the start of production at the Maonda mines, which were officially inaugurated on October 2, 1962. The mines are planned for an eventual production of 1,000,000 tons from 500,000 tons initial production. Mining is done by COMILOG which is controlled in the following manner :—

Bureau de Recherchs Geologiques at

Minieres	22%
Compagnie de Mokta	14%

Societe Auxiaire du Manganese de Franceville (SAMAF), Compose par tiers de la compagnie de Mokta, de la C. M.O.O. et dela

Bamque de Paris & des Pays-Bas	15%
United States Steel Corporation	49%

Long term fiscal benefits were given to COMILOG to instal industrial equipment of the values of \$12·00 million. Mining is reported to be done by drag-lines followed by simple mechanical operation of washing etc.

7.04 **Ghana**

At Nsuta mine, mining is carried out by open cast methods along benches upto a mile in length and usually 20 ft. in height (occasionally small tonnage of low phosphorous ore have been extracted by underground mining). Steam and diesel shovels are used for stripping overburden and extracting the ore. The ore is conveyed by rail to the washing plant, which is capable of handling about 3,000 tons of ore per day.

7.05 **United States of America**

At Montana, U.S.A., square-set stoping is adopted. Some of the low grade United States deposits, because of their size and manner of occurrence, offer possibilities for development and use of exceptionally low cost mining methods. Dredging has been suggested for consideration at Chamberlain and induced caving at Artillery Peak.

7.06 **India**

In India a large proportion of the manganese ore is mined in open-pits, which are shallow in lateritoid type of ores while in the hilly region they extend to considerable depths. Mining is carried out mostly by manual labour and therefore employment of a large labour force is necessary. Though manganese mining in India is an old industry, the method of mining has not materially progressed from the earlier stages of quarrying. In periods of boom the ore has been mined in a

reckless manner at many places without any regard for residual reserves or future developments. The mine-owners or their agents were, then generally motivated by a strong desire to grab and get away with as much ore as possible in the short run. Some time barely the surface of manganese bearing areas was scratched; zigzag trenches and indiscriminate pits were dug regardless of the extent or pattern of the ore body. The waste material was dumped over the hidden extension of the ore-body with the result the man made accumulation created became a barrier to natural access to mineable ore.

In a normal mining operation if the ore-body is thick, benches of convenient heights are created in the open pits. If the ore is not hard, it is removed with crow-bars taking advantage of the divisional planes in the deposits. Big blocks detached after blasting are broken up. Bastkets filled with ores are carried by manual workers to the mine-cars.

In order to avoid labour trouble, the management prefers to get these operations executed through the agency of contractors who employ the necessary labour force, only technical supervision being contributed by the mine managers.

Although in case of a large number of mines, the mining operations do not follow any concerted or well thought out plan of development, there are a few bright exceptions. For example, the group of mines controlled by Manganese Ore India Ltd., M/s Sandur Manganese and Iron Ores (P)Ltd., and few other companies have planned the lay out of their mines in a systematic manner. Shrinkage stoping, square-set mining and cut and fill method of mining are some of the techniques adopted by them in their underground mines.

7·07 Development Programme over the Next Five years period

The Committee made an attempt to examine the development programme of manganese mining industry in the country during the next five year period. The Shivrajpur Syndicate and the Manganese Ore India Ltd., are the only mining companies which furnished the necessary data. The Shivrajpur mines, however, have since closed down because they could not market their high phosphorous ore in the present market conditions. The Manganese Ore India Ltd., are planning to raise their production to about 4,60,000 tonnes per year by 1970 by exploiting new reefs in the existing working mines and also by opening new mines. A capital expenditure of Rs. 30,000,000 is envisaged. The capital required will cover sinking and equipping of 8 shafts and erecting and commissioning of one heavy media separation plant. It also provides for the purchase of new dumpers, bull-dozers, drills, compressors, loco-motives, trucks, tubs, tram lines, fans etc.

7·08 Scale of Operations

Table 1 gives distribution of manganese ore mines according to production for the year 1957-62. In 1957, the peak year of production, 604 mines contributed to a total production of about 1·6 million tonnes.

Out of this, 355 mines fell within production range of less than 1,000 tonnes per annum, and were responsible for 7·3 per cent of the total production. Another 54% of the total production came from 213 mines with annual production range of 1,000 tonnes to 15,000 tonnes. The remaining production was accounted for by comparatively larger units producing between 15,000 tonnes to 60,000 tonnes per annum. During the year 1962 the number of the first group of mines with production of less than 1000 tonnes per annum fell to 339 accounting for 6% of the total production. The second group with production ranging 1000 to 15000 tonnes came down to 118 in number and were responsible for about 43% of the total production. The number of larger units remained more or less the same. In fact, the mines with production range of about 60,000 tonnes per annum were responsible for 15% of the total production in 1962 as against 9% in 1957. It is of interest to note that, despite slump in the market, the operations of the larger units were not seriously affected although these units cannot be classified as really large in comparison with the important manganese mines in other major manganese producing countries.

The broad conclusions that emerge from the above analysis is that in such a highly competitive market as manganese, only sizeable units which are in a position to adopt modern techniques of mining and realise economies of scale, can afford to remain in production in the long run.

7·09 **Mining Cost**

Tables 2 and 3 give direct cost of development and mining including overheads in various production sectors in India. The tables have been compiled from the data supplied by the mine-owners in response to the questionnaire issued by the Committee. These data are, however, not enough to draw any positive inference regarding the mining cost. The Indian Bureau of Mines has collected some data on this subject which is given below :—

"The cost of production as reported by about 417 working mines each with production of less than 1,000 tonnes which contributed 7·2% of the total production in 1961 varies from Rs. 10·00 to Rs. 110·00 per tonne. The cost of production in mines with production ranging between 1,000 and 15,000 tonnes per annum is reported to vary between Rs. 8·00 and Rs. 156·00 with maximum concentration between Rs. 14·00 and Rs. 24·00. Working mines within this range of cost of production numbered 109. The production cost of mines producing 15,000 tonnes or more varies from Rs. 15·00 to Rs. 81·00 with a large number of mines producing at a cost of Rs. 30·00 to Rs. 42·00 per tonne. In most of the underground mines the cost of production ranges between Rs. 63·00 and Rs. 78·00 per tonne".

Due to the friable nature of the walls, relatively costly methods of mining are adopted in some of the underground mines such as square-setting at Bharwalli mines. In Madhya Pradesh the mining cost in open cast mines is abnormally high excepting those which are mechanised. In reef deposits it may be possible to adopt underground mining instead of labour intensive open-cast. Wherever the

walls are of gondites, open stoping may be adopted which will greatly reduce the mining cost.

Due to the erratic and pockety nature of manganese ore deposits the recovery factor is rather low. The ratio between the waste rock to the lode material may be 1 : 10—20 About 50—80% of the lode material is · recoverable as marketable ore. The average recovery of marketable ore, therefore, may come to about 5—10% only. In underground mines, however, the recovery may average 75%.

The low recovery factor involves considerable amount of dead work in excavating the hanging wall and footwall rocks and stripping of the overburden. And all this is done, in most of the mines, by manual labour where, inspite of the drudgery of human toil, the output per man shift is drastically low. The Committee is of the view that with the adoption of partial mechanisation it should be possible to achieve reduction in mining costs. As all mine owners may not be in a position to own and use costly mining machinery like bulldozers, compressors, transport vehicles, pneumatic rock drills etc., it would be desirable to maintain a pool of these equipments at some central location which could be made available on hire to mine-owners. This could be handled by either a co-operative of manganese miners or a Government department like the Indian Bureau of Mines or a public undertaking like M.M.T.C. who are, at present, the largest single organisation for buying and marketing of manganese ore.

Co-operative departments of the State Governments or any central agency responsible for production or procurement of ores should provide necessary leadership for organising, wherever possible, small mining units into co-operative societies for one or several purposes, *e.g.* provision of capital finance, purchase of equipment, operational knowhow, marketing and sales. It would be a practical proposition to plan for a production of 50,000 tonnes per annum through mechanised mining from major ore deposits having ore reserves of the order of 2 to 2·5 million tonnes or higher. In the case of smaller ore deposits containing reserves of the order of 1·0 to 2·0 million tonnes, an annual production of 30,000 tonnes could be planned on the basis of partially mechanised or manual mining. A mechanised open-cast mine of the capacity of 60 to 70 thousand tonnes per annum may require an investment of about 50 lakhs of rupees. To encourage mechanisation of such relatively small scale mines, Government might consider a suitable scheme of fiscal and tax incentives. (Please see details in Chapter on 'Mining legislation and Fiscal Levies') Exporters of manganese ore are at present permitted to import mining machinery to the extent of 10% of the value of their exports. The Committee recommends that the concession should be further liberalised by raising the limit of import entitlement to 25% of the value of exported ore.

7·10 Mines Management and Financing

As has been indicated earlier in this chapter majority of the manganese mines in India are small mines owned mostly by private individuals who work them partly with their own meagre capital and partly

with capital given to them by promotors. There are only a few mining concerns which operate under corporate management. These companies, account for major share in the production of the country and play a predominant part in the export trade. The total capital investment of these companies is hardly in the neighbourhood of Rs. 5·00 crores. The capital employed per tonne of annual capacity may come to about Rs. 50·00.

The table below gives capital employed by important companies together with their production.

Name of the firm	Capital employed Rs. in lakhs	Year to which the figure in Col. 2 relates	Production in metric tonnes	Year to which production relates
1	2	3	4	5
Manganese Ore India Ltd. . .	267·31	1963-64	308,632	1964
The Sandur Manganese & Iron Ore Ltd., Sandur.	49·38	1961	105,703	1961
Shivrajpur Syndicate Ltd. . .	77·73	1960-61	74,761	1960-61
Best Minerals (P) Limited . .	11·13	1960	14,145	1960
M. A. Tullock & Co., Ltd. . .	12·34	1960-61	34,978	1960-61
Orissa Manganese & Minerals (P) Ltd.	14·32	1960	9,729	1960
Pacific Minerals (P) Ltd. . .	7·89	1961	25,536	1961

Capital employed = Fixed Capital + Working Capital.

As against this picture the investment in the year 1958, in the development of Brazilian deposit was $ 50 million for a production of about 600,000 tonnes and in Gabon $ 12 million were invested in the year 1961 for an initial production of 500,000 tonnes per year.

Conversion of numerous small unsystematically worked mines into relatively fewer scientifically operated economic units will necessarily involve large capital investment. On the other hand, finance is not attracted to mining industry as much as it is to other industrial undertakings. Mineral industry has to reckon with certain inherent disadvantages. Occurances of mineral deposits are localised and restricted in extent and variable in grade and quality. Investigations for new deposits at times run an unpredicted course; and the rewards are uncertain and attended by hazards, financial and physical. Mineable researves are necessarily wasting assets and mining operations calculated to improve output inevitably lead to rapid depletion of known deposits. There is also the risk of obsolescence, development of new technology is likely to result in discovery and use of new substitutes for ores. Besides, there is always a possibility of discovery of new deposits in other parts of the world. In fact, competition from new sources of supply recently discovered and developed in other parts of the world has contributed greatly to uncertain conditions in the international market for minerals. Investment in minerals is beginning to be considerd a very risky venture.

For this reason there is particular need for supplementing the resources of private investors with assistance from the existing financing agencies like Industrial Credit and Investment Corporation, National Investment Development Corporation and Industrial Finance Corporation which should be specially oriented to look after the needs of manganese industry. Taking into consideration the conditions of the mining industry in the country in general, the committee feels that there might be a case for the creation of a Mining Finance Corporation in the Fourth Plan which would particularly cater to the needs of mining industry in all important basic minerals.

Conclusions

(1) Manganese mining operations in various parts of the world cover a wide range of modes of production, from manual quarrying dating back to about a century to modern sophisticated methods and techniques. The major portion of world's manganese ore production is, however, derived from open pit or shallow underground workings.

Open pit mining is the pattern which obtains in case of the majority of mines in India, South Africa, Brazil and Congo. Underground mining is generally the rule in U.S.S.R., U.S.A., Chile, Morrocco, Cuba and is also a prominent feature of a few important deposits in India.

The Russian mines have been developed to an annual production capacity of ten million tonnes. Brazilian and Gabonese mines are at present geared for an annual output of 1 million tonne each.

(2) In India, small mines are a predominent feature of the manganese industry. In the year 1962, 475 mines accounted for a total production of 1.2 million tonnes out of which small-scale units producing less than 10,000 tonnes per year were responsible for 48% of the production. There were only two mines with annual production range of 60,000 tonnes.

(3) In a highly competitive market as manganese, only sizeable units which can adopt modern techniques of mining and realise economies of scale can afford to remain in production in the long run.

(4) With the exception of a few companies, majority of mine owners have slender financial resources, which at times, are supplemented by financial assistance from promoters. The total capital investment in manganese industry would be of the order of Rs. 5 crores only. As against this the investment in the development of Brazilian deposits amounted to $ 50 million in 1958 for a production of about 600,000 tonnes of manganese ore, and in Gabon in 1961 a capital outlay of 12 million $ was in relation to a production of 500,000 tonnes (expandable to one million tonne) per annum.

Recommendations

(1) In order that Indian manganese industry may face the present competitive conditions of world market, it is necessary for mining units to adopt scientific techniques of mining and operate on an economic scale of production.

As all mine-owners are not in a position to acquire, service and maintain costly mining machinery such as bulldozers, compressors, transport vehicles, pneumatic rock drills etc., it should be possible to constitute a pool of such essential equipments at a central point from where it could be made available to mine-owners on suitable terms. This could be handled by either a co-operative of manganese miners or a Government department like the Indian Bureau of Mines or a public undertaking like the M.M.T.C., who are, at present, the largest single organisation for buying and marketing of manganese ore.

(2) The present concession of entitlement for import of mining machinery against 10% of foreign exchange earnings, should be extended upto 25% of the value of exports.

(3) Co-operative departments of the State Governments or central agencies responsible for production or procurement or marketing should provide necessary leadership for organising wherever possible, small mining units into co-operative societies for one or several purposes, *e.g.*, provision of capital finance, purchase of equipment, operation know-how, marketing and sales.

(4) To encourage mechanisation and adoption of modern scientific techniques, Government might consider a suitable scheme of fiscal and tax incentives (please see details in Chapter on 'Mining legislation and Fiscal Levies').

(5) For major ores deposits containing reserves of 2 to 2.5 million tonnes or higher, the economic scale of production of a mechanised mine would be of the order of 50,000 tonnes per annum. In case of smaller deposits containing reserves of the order of 1 to 2 million tonnes an annual production of 30,000 tonnes could be planned on partially mechanised or unmechanised basis.

(6) To meet the requirements of capital investment on equipment and machinery, the existing agencies like Industrial Credit and Investment Corporation, National Investment Development Corporation and Industrial Finance Corporation should be specially oriented to look after the needs of manganese industry. Taking into consideration the conditions of the mining industry in the country in general, the committee feels that there might be a case for the creation of a Mining Finance Corporation in the Fourth Plan which would particularly cater to the needs of mining industry in all important basic minerals.

Table 1 : Distribution of Manganese Ore Mines according to production 1957-1959

Production Group (Tonnes)	1957			1958			1959		
	No. of Mines	Total Production from the group (in tons)	Percentage of total Production	No. of Mines	Total Production from the group (in tons)	Percentage of total Production	No. of Mines	Total Production from the group (in tons)	Percentage of total Production
1	2	3	4	5	6	7	8	9	10
Upto 100	94	4,253	0·3	81	3,797	0·3	211	6,435	0·5
101 500	164	45,957	2·8	116	32,475	2·6	116	44,981	3·8
501 1000	97	70,012	4·2	66	38,257	3·1	63	64,635	5·4
1001 2000	84	118,386	7·2	50	61,268	5·0	58	86,847	7·3
2001 5000	82	263,450	15·9	41	128,987	10·5	339	122,067	10·3
5001 10000	50	338,932	20·5	14	91,333	7·4	20	142,732	12·0
10001 15000	13	160,760	9·7	12	157,240	12·6	9	113,537	9·6
15001 20000	7	125,014	7·6	8	129,423	10·5	9	149,202	12·6
20001 25000	2	42,126	2·6	4	98,736	8·0	11	24,716	2·1
25001 30000	3	81,630	4·9	1	28,238	2·3	2	56,990	4·8
30001 35000	1	32,242	1·9	—	—	—	2	67,027	5·6
35001 40000	1	36,623	2·2	2	77,205	6·3	—	—	—
40001 45000	1	43,771	2·6	1	41,262	3·3	2	87,768	7·4
45001 50000	2	94,478	5·7	3	140,017	11·4	1	49,769	4·2
50001 60000	1	50,621	3·1	1	58,855	4·8	3	170,719	14·4
Above 60000	2	145,939	8·8	2	146,464	11·9	—	—	—
	604	1,654,194	100·00	402	1,233,557	100·00	536	1,187,433	100·00

Table 1—(*Contd.*): Distribution of Manganese Ore Mines according to production 1960-1962

Production Group (Tons)	1960			1961			1962		
	No. of Mines	Total Production from the group (in tons)	Percentage of total Production	No. of Mines	Total Production from the group (in tons)	Percentage of total Production	No. of Mines	Total Production from the group (in tons)	Percentage of total Production
1	2	3	4	5	6	7	8	9	10
Upto 100 . . .	188	3,745	0·3	218	4,839	0·4	180	3,217	0·3
101 500 . . .	154	45,265	3·8	128	34,431	2·8	106	30,182	2·5
501 1000 . . .	84	65,638	5·5	71	51,738	4·2	53	38,214	3·2
1001 2000 . . .	52	77,175	6·4	42	58,443	11·8	36	50,672	4·2
2001 5000 . . .	40	118,609	9·9	42	139,516	11·3	46	149,941	12·4
5001 10000 . . .	29	205,791	17·2	21	155,927	12·7	26	193,024	16·0
10001 15000 . . .	11	136,522	11·4	10	123,883	10·1	10	122,385	10·1
15001 20000 . . .	5	85,669	7·1	6	101,244	8·2	5	85,189	7·0
20001 25000 . . .	1	23,801	2·0	3	66,457	5·4	2	44,208	3·6
25001 30000 . . .	—	—	—	1	26,290	2·1	3	78,573	6·5
30001 35000 . . .	4	135,023	11·3	1	34,025	2·8	3	95,399	7·9
35001 40000 . . .	1	37,181	3·1	3	112,672	9·2	1	39,410	3·3
40001 45000 . . .	1	40,828	3·4	1	43,515	3·5	1	40,635	3·4
45001 50000 . . .	—	—	—	1	49,364	4·0	—	—	—
50001 60000 . . .	1	53,412	4·4	1	57,865	4·7	1	57,074	4·7
Above 60000 . . .	2	170,106	14·2	2	169,815	13·8	2	180,684	14·9
	573	1,198,765	100·00	551	1,230,024	100·00	475	1,209,007	100·00

Table 2 : Direct cost of Development and Exploration.

Cost/tonne of finished ore (Rs.)

Production Sector	Stripping of over-burden and hanging & footwall rocks	Access Roads	Development in hanging & footwall barren rock	Shaft Sinking	Under-ground driving	Pitting trenching etc.	Total (on the basis of actual minewise costs)
Orissa	6·17—36·00	0·75—2·14	1·36	—	—	2·00—3·00	2—38
Mysore	N.A.S.	N.A.S.	N.A.S.	—	—	N.A.S.	35
Gujarat	1·61	—	0·79	0·28	0·58	—	3·26
Madhya Pradesh & Maharashtra	24·49	—	2·65—136·04	—	0·69	8·50	10—136
Andhra Pradesh	—	—	—	—	—	—	11

N.A.S. = Not available separately.

Table 3 : Direct mining cost including mine overheads in various production sections.

Cost/tonne of finished ore (Rs.)

Production Sector	Drilling	Blasting	Under-ground haulage	Surface haulage	Support	Power	Miscellaneous	Total (on the basis of actual minewise costs)
Orissa . . .	0·19—3·00	0·59—3·00	Nil	1·00—8·80	Nil	1·00—2·50	4·00—5·50	5·00—15·00
Mysore . .	2·99	2·47	Nil	3·26	Nil	Nil	1·51	10·23
Gujarat . .	0·59	0·55	0·15	0·41	0·39	N.A.	30·90	32·99
Madhya Pradesh & Maharashtra .	0·11—14·29	0·24—9·80	0·16	0·18—17·38	1·75	0·24—2·25	3·40	6·52

CHAPTER VIII

MINING LEGISLATION AND FISCAL LEVIES

8.00 Legislation is powerful instrument of Government policy, which can be used effectively to stimulate the development of mineral industry. Unlike other sectors of industry, exploitation of mineral involves certain risks and hazards which are inherent in the uncertainty and relative costliness of prospecting operations and mining. It is, therefore, important that suitable incentive should be built in the mining laws to attract enterprising prospectors and to induce entrepreneurs to deploy their managerial skills and capital resources in this field. Mining legislation in India, at present, covers all important aspects such as disposition of mineral rights, conservation of resources, miner's safety, labour amenities and taxation. Each of these aspects could be oriented to sub-serve the long term objective of development.

8.01 At present, by and large, prices of Indian manganese ore are not competitive in the international market. There are several factors which contribute to the higher cost of production in India. Detailed discussion of these will be found in other chapters of the Report. Besides these, there are fiscal levies which constitute an important element in the cost structure of manganese ore. Salient features of these levies are described in the following paragraphs :—

(*a*) *Income Tax.*—Generally in all industrialised countries, a new mine is given an opportunity to recover, before the imposition of taxes, a large part of the capital expenditure required to develop and start production. A three year tax exemption period for new mines, income tax allowances for pre-production cost, generous depletion and depreciation allowances, exemption from Capital Gains Tax and special excise and customs tariff provisions, are some of the special incentives provided to the mining industry. In Table I, an attempt has been made to compile a comparative statement of concessions allowed in the taxation laws of U.S.A., Canada, South Africa, Australia and India.

Under the Indian Income Tax Rules, 1962, the following depreciation allowances and development rebate are provided :—

A. DEPRECIATION ALLOWANCES :

Mines and Quarries (No extra shift allowance admissible)	*Depreciation in Rate*
(a) Machinery.	
(i) Surface and underground machinery (except electrical machinery), headgear, moving and rails.	15%
(ii) Boilers and Head-gears (Excluding moving parts)	8%
(b) Coal tubs, winding ropes, haulage ropes and sand stowing pipes.	Nil (Renewal is allowed as revenue expenditure).
(c) Shafts and inclines	7%
(d) Portable underground Machinery	25%
(e) Safety lamp	Nil (Cost of lamps actually used up will allowed as revenue expenditure).
(f) Tramways on the surface	10%
Earth moving machinery employed in heavy construction work such as Dams, Tunnels, Canals etc. (No extra shift allowance admissible)	
(a) Tractors	25%
(b) Dumpers	20%
(c) Motors, Graders, Tourapul, Scrappers, Excavators, Ropter Tourna Dozer.	15%
Rope-way structures (No extra shift allowance admissible)	
(a) Trestle and station steel work	6%
(b) Driving and tension gearing	10%
(c) Carriers	12%
(d) Ropeways ropes and trestle sheves and connected parts.	30%

B. DEVELOPMENT REBATE :

(a) Installed before 1st day of April, 1961	25%
(b) Installed after 31st day of March, 1961	20% of the actual cost of machinery or plant.

In this connection it may be pointed out that in Canada 100 per cent depreciation allowance is allowed on development expenses *e.g.*, shaft sinking, haulage, ventilation, etc., as against 7 per cent. depreciation allowance provided for shafts and inclines in India. On most of the mining equipment, 30 per cent. of depreciation allowance is provided in Canada as against 15 per cent. in India. Besides these, depletion allowance and tax holidays are also given in other countries which are non-existent in India.

The Committee feels that the depreciation allowances etc., permitted under the Indian Income Tax Laws are not commensurate with the risks and hazards involved in mining ventures. Some encouragement by way of tax concessions and higher depreciation allowance

therefore, seems necessary if risk capital is to be attracted to this industry. Keeping in mind the concessions, generally provided to mining industry in other industrialised countries, the following reliefs are suggested :—

(i) Expenses incurred on prospecting and exploration should be treated as revenue expenditure.

(ii) Tax holiday for 3 years for new mines should be given.

(iii) Permissible depreciation allowance for mining machinery and equipment may be increased to 30 per cent.

(iv) Expenses incurred on research and pilot plants in beneficiation or upgrading of ore should be treated as revenue expenditure.

(*b*) *Sales Tax*.—After Income Tax, Sales Tax is the second important element in the high cost of production of manganese ore which is ultimately reflected in the export price. At present, two types of sales tax are levied *viz*., (i) central sales tax under the Central Sales Tax Act, 1956 on sales in the course of inter-State trade ; and (ii) local sales tax levied under the Sales Tax Acts of various State Governments on intra-State sales. Both these taxes are administered by the State Governments. On 'declared' goods the rate of Central Sales tax is subject to maximum of 2 per cent and on other goods (which includes manganese) the rate is 10 per cent. except that whenever the rate of tax under the local law is higher than 10 per cent. on any goods the said higher rate applies to the inter-State sale. When sales are made to dealers registered under the Central Sales Tax Act and to Government against appropriate certificates in prescribed forms, the rate is 2 per cent. If the rate of local tax is lower or if the commodity is exempt from tax, the rate of Central Sales Tax is also to conform to the local tax pattern. Local Sales Tax laws and the rate of taxation vary from State to State—from 3 per cent. in Andhra Pradesh and Mysore to 4½ per cent in Bihar, 5 per cent. in Orissa, 5¼ per cent. in Maharashtra, 6 per cent. in Rajasthan and Madhya Pradesh and 6¼ per cent. in Gujarat in respect of Manganese ore. These percentages, however, do not indicate the exact burden of the tax as it is, often, levied at more than one point if the ore passes through several hands or intermediate agencies before export.

A summary of sales tax provisions as they affect manganese ore trade in various States will be found at Table 2.

Effect of Sales tax on export

Under the Constitution no tax on sales or purchase "in the course of the import of goods into or export of the goods out of the territory of India" is permissible. The Central Sales Tax Act, 1956, defines the 'course of export' as follows :—

"A sale or purchase of goods shall be deemed to take place in the course of export of goods out of the territory of India only if the sale or purchase either occasions such export or is effected by a transfer

of documents of title to the goods after the goods have crossed the customs frontiers of India."

It is clear from the above definition that when a dealer directly exports a commodity, the sale is not liable to be taxed but where he sells it to another person who in turn exports it, the first sale attracts the provision of the sale tax but the second does not. Sales tax concessions in respect of sales preceding exports exist in some States. In West Bengal all transactions involving sale or purchase of commodities by any number of intermediary dealers prior to their export are exempt from sales tax. In Bihar and Madhya Pradesh sales which take place in the course of export of goods out of the territory of India are exempt from the levy of sales tax. Some other States such as Uttar Pradesh, Gujarat, Maharashtra and Rajasthan allow exemptions or rebate of local sales tax on transactions immediately preceding the export of goods.

Incidence of Sales Tax on Cost

It is not possible to evaluate the exact incidence of this tax due to the varying procedures and rules of taxation in force in different States. The Sarayia Committee which has gone into this question in greater detail has observed that "any incidence of sales tax, however small it may appear by itself in the total price, acts as a built-in handicap when facing the rigours of world competition in the free for all international market".

The exports of manganese ore may be made either by a mine owner or a shipper. In the case of mine owner, the export contract will be with the foreign buyer. Such export sales will not require any protection as they are exempt from Sales Tax. The Shipper, if he is not himself a mine-owner or if his own production is insufficient to meet his export commitments, has to procure the ore either locally in one state or more states. In either case, his transactions will attract liability to tax under the present laws. As the ore procured by the Shipper is ultimately exported, the levy of sales tax on such ore unduly inflates its cost. It is accordingly suggested that State Governments should be requested not to levy sales tax (Central or Local) on such manganese ore intended for export. Alternatively, it is suggested that the State Governments may adopt the West Bengal system of taxation.

(c) *Local Taxes.*—It is reported that some of the State Governments have brought certain mining areas under the purview of Municipal Taxation and Gram Panchayat rules. The tax is levied on machinery, buildings, etc. In this connection it may be pointed out that in some cases suitable amenities such as hospitals, dispensaries, creches and canteens, conservancy, sanitation and other services are already provided by the mine owners in mining townships. In such cases the levy of local taxes is hardly justified. Such areas should, therefore, be exempted from municipal or gram-panchayat levies. In areas where adequate facilities are not provided by the mine owners, the levies may be imposed at the minimum rates raprovided under the rules.

(*d*) *Shipping freight*.— It has to be recognised that India is somewhat unfavourably situated in regard to the distance between the ports of exports in the country and traditional markets of Indian manganese ore. For example Indian manganese ore has to travel about 9,800 nautical miles from Vizag port to New York port (U.S.A.) whereas the distance between Porto Macapa in Brazil and U.S.A., which is the main consumer of manganese ore, is about 2,900 nautical miles. As such, the freight rates on manganese ore from Indian ports to consuming centres are considerably higher than the freight charges from the new sources of supply, which are comparatively nearer. This aspect of the problem and other connected matters have been discussed in detail in chapter on "Transportation and Port Handling".

Apart from the above, the other factors contributing to higher freight rates are (a) income tax on freight earnings which the ship-owners are required to pay on their gross earnings, and (b) the canal toll dues which vessels carrying mineral ores have to pay to Suez Canal Authorities. Both these have the effect of inflating the actual ocean freight charges from Indian ports to the consuming markets. As it is important to maintain the competitive ability of Indian manganese ore in the international market, it is felt that some relief should be secured for manganese ore in this direction.

(*e*) *Royalty and Dead Rent*.—The payment of royalty to the owner of the mineral rights is another important element of the cost in mining. Before 1948, mines and minerals were being regulated by the Mining Concession (Central) Rules, 1939, which had no statutory basis but were in the nature of executive instructions issued by the Central Government. These rules operated in the Centrally administered areas only. The Provincial Governments had their own rules which operated in the provinces. The Industrial Policy Resolution of 6th April, 1948, which contemplated Central control and regulation of minerals, led to the enactment of the Mines and Minerals (Regulation and Development) Act, 1948. The Mineral Concession Rules, 1949, which were framed thereunder, prescribed for the first time uniform rates of royalty on an all-India basis. The rates of royalty on manganese, as in the case of other minerals, were prescribed as a *fixed percentage* of the sale price at the pit's mouth. When the 1948 Act was replaced by the Mines and Minerals (Regulation and Development) Act, 1957, with effect from 1st June, 1958, the rates of royalty on minerals continued as *fixed percentages of the sale price of the minerals at the pit's mouth*. Although the concept of "pit's mouth value" has been in vogue for decades, at no stage till recently any attempt has been made to define this notional concept. It is basically notional because, in practice, hardly any sale takes place at the pit's mouth. However, for purposes of calculating royalty, the practice followed in most of the States is that the sale value of the mineral at the pit's mouth is worked backward from the *sale price* of the mineral after deducting charges on account of transport, handling, etc.

This procedure has been generally accepted as the working rule for calculating base value on which royalty is levied. In December

1952, the Government of Orissa decided to incorporate in all the leases, *inter alia*, the following clause, regarding payment of royalty :—

"*Mode of arriving at Pit-head value for the purpose of computing royalty* :—Notwithstanding any proof that may be produced by the lessees of sale at pit's mouth of the ore at any lower price, for the purpose of calculation of royalty, the pit's mouth value shall be calculated back from the price of the ore at recognised markets for the ore in the country. The State Government shall declare from time to time in the commercial bulletins or Government statistical bulletins from which the prevailing price shall be ascertained for the important markets for the mineral. *The State Govt. shall also declare from time to time what they consider fair price* of the mineral at the market or markets recognised by the trade and also what they consider fair transport and handling charges for the mineral from the pit's head to the important markets either in general or for specific mines. The highest price at the pit's head on the basis of such prices and transport and handling charges shall be taken as the sale value at pit's mouth."

The State Govt., were to declare from time to time the prices of minerals which they intended to adopt as the pit's mouth value. It is only merely six years later that they issued a notification No. XVII-M.G. 5/58-3951-M.G. dated 27-5-58 in which they promulgated the prices for the period 1953 to 31-5-58. Subsequently in April '61, the State Govt., issued demand notices on the mine-owners asking them to pay the arrears of royalty for the period July '53 to June '60 on the basis of the prices notified by them on 27-5-58 and thereafter. On this some of the affected parties moved the High Court of Orissa for redress against the method adopted by the State Govt. for computation of royalty. The High Court, however, ruled that the lessees should approach the Central Govt., first to seek redress of their grievances as provided for under the Mines & Minerals (Regulation & Development) Act, 1957, and Mineral Concessions Rules, 1960. Accordingly, a large number of applications were filed in 1962-1964 by these mine-owners to the Central Govt. for review of the orders of the Government of Orissa.

It is understood that the Central Govt., have recently decided to reject revision applications of certain mine-owners who had signed on lease deeds agreeing to pay royalty to the State Govt., in accordance with the mode of calculating pit-head value to be determined by the State Govt. In the case of other mine-owners who had not agreed to such a stipulation, the State Govt., has been asked to determine the amount of royalty on the basis of actual sale price of the mineral obtained by the parties, making suitable deduction for cost of transport from the mines to the port. The Committee hopes that this dispute which has been a matter of serious concern to manganese industry in Orissa will be amicably settled to the satisfaction of mine-owners.

It may also be pointed out that some mine-owners in Mysore State filed writ petitions in the High Court of Mysore questioning the validity of the levy of royalty at the fixed rate of Rs. 1·50 per tonne of iron ore

prescribed by the Central Government in Notification No. MII-152(26)/62 dated 31-10-62. The High Court in their judgement dated 26-3-64 have, among other things, made certain important observations :—

'*Sale Price*' is not defined either in the Act or in the rules framed under the Act. In the absence of such definition in the Act or the rules, the expression "sale price" has to be considered in its popular sense. Under the Sale of Goods Act, 1930, "price" is defined by Section 2 (10) as meaning "money consideration for the sale of goods". Interpreted in this light, *the sale price contemplated by the proviso to sub-section* (3) *of Section* 9 *would mean money consideration for which iron ore is sold at the pit's head*". The liability to pay royalty under Section 9 is on "the holder of a mining lease" and it has to be fixed with reference to "the sale price of the mineral at the pits' head". So the sale price contemplated by the Act is the price for which the ore is sold at the pit's mouth by the holder of a mining lease. In none of the cases involved in the writ petitions has it been shown to us by any of the respondents that the petitioners had realised Rs. 7·50 or more per ton for the iron ore disposed of by them at the pit's head. In that view none of the petitioners would be liable to pay royalty at the enhanced rate in respect of the ore sold by him. The notification may become enforceable against them when they realise Rs. 7·50 or more per ton as sale price at the pit's head. It will be valid in such parts of India where the holders of mining leases realise the sale price at the aforesaid rate and the enhanced rate of royalty will be within the limits laid down by the proviso to sub-section (3) of Section 9 of the Act."

It will be observed from the above that the royalty payable by the mine-owners is to be *calculated on the basis of their actual selling price of the mineral.* The ruling of the Mysore High Court dated 26-3-64 is of very great importance as it has clearly enunciated the significance of the concept of the term "pit's head value", in terms of the 'sale price' or money consideration for which mineral is sold at the pit's head. In view of this, the concept of pit's head value as the price notified by the State Government as fair price of the mineral is hardly tenable, when figures for actual price realisations are available.

The Committee recommends that wherever departmental rules or instructions are not in accord with the principle enunciated in this judgement, immediate steps should be taken to modify or amend such rules and instructions and afford relief wherever it is due.

As regards the quantum of the rates of royalty of manganese ore, it has been observed that the rates have undergone several changes since 1949. There was upward revision of these rates in 1957 when there was a great demand for manganese ore and boom conditions prevailed in the world market. In 1958, when the prices of Indian manganese ore showed a sharp decline, the rates of royalty were reduced. In view of the continued depression in manganese market, there was a further downward revision of the rates in 1960. In November '62, the following flat rates of royalty were prescribed for the first time on tonnage basis

to avoid complications in calculating royalty on the basis of a fixed percentage of the sale price of the mineral at the pit's mouth :—

Dioxide ore	Rs. 15·00 per tonne.
45% Mn & above	Rs. 6·00 per tonne.
35—45% Mn.	Rs. 3·00 per tonne.
Below 35% Mn.	Rs. 2·00 per tonne.

In the context of the rapid decline of the FOB prices of manganese ore since 1960, the above rates of royalty do not appear to be justified and have brought about additional burden on the industry. The Committee accordingly, recommends the following rates of royalty for manganese ore :—

	Per tonne
Dioxide ore . . . . (MnO$_2$ 78% & above, Fe 4% Maximum)	Rs. 10·00
45% Mn and above	Rs. 4·00
35—45% Mn.	Rs. 2·00
Below 35% Mn.	Re. 1·00

Owing to continued depression in manganese market, a number of manganese mines have stopped production during recent years. This has resulted in accumulation of heavy arrears of dead rent payable by the mine-owners to the State Governments. The Committee feels that dead-rent for the last three years should be waived (this recommendation has been referred to the Ministry of Commerce in advance of submission of the report) and for the rest, if any, the State Governments should be advised to collect it in instalments equal to the amount of royalty chargeable per tonne of ore on resumption of production. This will act as an inducement to mine-owners to re-open mines and start mining operations.

(*f*) *Manganese Mines Labour Welfare Fund.*—On the recommendations of the Industrial Committee on Mines other than coal, the Ministry of Labour & Employment proposed in 1961 to enact legislation to provide for the levy of a cess on manganese exported from India for financing activities to promote the welfare of labour employed in manganese mining industry. The Committee noted that the proposal for enacting legislation to constitute the above fund has been deferred in view of depressed market conditions. It may be pointed out in this connection that any labour welfare measure calculated to add any burden, however little it may be, to the cost of manganese ore, will further affect its competitive capacity in the international market. It is accordingly recommended that the legislation to create the fund may not be enforced till this industry is fully rehabilitated and attains prosperity.

8—1 I. B. M. (N. D.)/65

8.02. Mining Legislation.

A. Disposition of Mineral Rights :

The policy followed for regulating mining industry in this country derives its authority from the Industrial Policy Resolution of 30th April, 1956 and the Mines & Minerals (Regulation & Development) Act, 1957. The broad features of this policy are :—

(1) The ownership of the minerals vests in the State Government who grant all prospecting licences and leases in this behalf and also derive income from royalties.

(2) The actual grant of leases in respect of some minerals specified in Schedule A of the Industrial Policy Resolution and the Act has to be approved by the Central Government. These minerals are iron ore, manganese ore, gypsum, lead, zinc, gold, sulphur and atomic minerals.

Under the Industrial Policy Resolution, 1956 manganese is a scheduled mineral and the responsibility for its exploitation mainly rests with the State. Accordingly, large areas of manganese ore have been reserved for exploitation in the public sector in various States and these are not being released to private parties, although the State Governments have no plans to exploit them. The Committee does not favour this hold-up. It is necessary in the interest of proper development of mining industry to let the private sector exploit such areas which the State Government do not intend to work in the near future. Special consideration should also be given for granting leases of suitable areas to the ferro-manganese industry so that wherever possible it can depend upon its own captive mines for a uniform and regular supply of ore.

The Committee further recommends that applications for mining leases in the reserved area should also be considered for the minerals other than the one for which it has been reserved provided that the working of mineral/minerals in the area applied for will not affect the development of the remaining part of the reserved area in the public sector.

B. Power of Revision of Central Government :

The Mineral Concession Rules, 1960 provide that an application for the grant of prospecting licence or mining lease shall be disposed of within nine months from the date of its receipt and, if it is not disposed of within that period, it shall be deemed to have been refused. Any person aggrieved by such deemed refusal or any order made by a State Government or other authority in exercise of the powers conferred on it by the Mines and Minerals (Regulation and Development) Act 1957, or the rules made there under may, within 2 months of the date of communication of the orders to him, apply to the Central Government for revision of the order. It has been brought to the notice of the Committee that in certain cases where the Central Govt. after necessary examination have passed orders in revision, the State Government have not complied with or given effect to the orders of the Central Government. Apart from the constitutional embarrassment involved,

such situations militate against the orderly development of mineral industry, in that they lead to unnecessary litigation which acts as a strong disincentive to enterprising prospectors and miners of new deposits.

The Committee strongly recommends that the powers of the Central Government in the matter of regulation and control of mining rights having been clearly defined in the Constitution, the State Governments should take steps to give immediate effect to the orders passed by the Central Government, on applications made to them under the provision of Mineral Concession Rules, 1960.

It has also been noted by the Committee that considerable time is taken in the disposal of review applications and no time limit is provided in the rules for the disposal of the applications by the Central Government. The Committee recommends that a reasonable time limit for the disposal of such applications should be provided for in the Minerals Concession Rules, 1960, so that redress to aggrieved parties is not unduly delayed or denied when it is most needed.

C. Safety in Mines and Labour Welfare:

As pointed out above, unlike other sectors of industry, exploitation of minerals involves certain risks and hazards which are inherent in their mining. Hence the need to provide for safety and welfare of workers can hardly be ignored. At the same time it has to be ensured that such measures do not put undue strain on the mine-owners and obstruct their normal working. At present, a number of safety and welfare laws which are in force in the country are listed below :—

(a) The Mines Act, 1952.

(b) Mines Rules, 1955.

(c) Metalliferous Mines Regulations, 1961.

(d) Mines Creche Rules, 1959.

(e) Mines Maternity Benefit Act, 1941.

(f) Mines Maternity Benefit Rules, 1943.

(g) Minimum Wages Act, 1948.

(h) Minimum Wages (Central) Rules, 1960.

Regulations, Rules and bye-laws formulated from time to time since the promulgation of the Mines Act in 1952, have a wide range of application. These rules and regulations have been formulated on the basis that mining is an organised industry. But in the case of manganese mining in India it is not so. More than 50% of manganese mines in the country are small with production range of about 1000 tonnes per annum. There are very few mechanised mines working at greater depths. Since the industry is in a diverse state of development, the general application of the rules in their present form to all mines irrespective of their size and scale of operations, is causing undue hardships to small mine owners. However, it is recognised that in the case of gold, coal and other metalliferous mines, strict regulatory measures are necessary for the safety and health of the workers employed.

It is accordingly felt that the existing rules and regulations may be relaxed in their application to mines worked on a small scale, which would go a long way in reducing the cost of production without endangering the safety or the health of the workers. A few of the rules whose application could either be limited or relaxed in so far as they relate to manganese ore mining are listed below :—

(*i*) *Conservancy.*—It is laid down under Section 20 of the Mines Act, 1952, and Rule 33 of the Mines Rules, 1955, that a sufficient number of latrines and urinals of prescribed types shall be provided for males and females separately in every mine. As the Manganese Ore mines are of the open cast type, most of the debris and gangue are dumped at convenient distances from the mines. The class of labour employed in manganese mining (the unskilled type) come from the surrounding rural parts and is unaccustomed to the use of confined places like latrines and urinals. In fact, wherever latrines and urinals have been provided by the mine-owners, the labour is not making use of them. It is accordingly felt that manganese mines may be exempted from the requirements of the above rules.

(*ii*) *Canteens.*—Rules 64 to 71 of the Mines Rules provide for opening and running of canteens where labour force is 250 or more. These lay down standards of construction, furniture and equipment, staff, etc. The labourers, who generally bring with them their lunch packets, hardly make use of a canteen. Thus the enforcement of the provisions of the above rules entails a heavy initial outlay on the part of the mine-owners with no particular benefit to the class of labour working in mines. It is accordingly felt that the requirement of these rules may be relaxed.

8.03. Conclusions

(*a*) Considering the risks and hazards inherent in mining ventures, it is important that suitable incentives should be built in mining and fiscal laws to attract enterprising prospectors and to induce entrepreneurs to deploy their managerial skills and capital resources in the field.

(*b*) Besides direct governmental levies such as royalty, income-tax, sales tax etc., stringent legislations on mineral disposition, safety and labour amenities are adversely affecting the exports of manganese.

(*c*) *Income Tax.*—(i) In most of the advanced countries a new mine is given the opportunity to recover, before the imposition of taxes, a large part of the capital expenditure. A three year tax-exempt period for new mines, income tax allowances for pre-production costs, generous depletion and depreciation allowances are some of the concessions given to the mining industry in Canada. Similar reliefs are also available in Australia, U.S.A., U.K. etc.

(ii) In India the Income Tax Act, 1961 and the Income Tax Rules, 1962 provide only for depreciation allowance and development rebate which are much low as compared to other countries. A few other concessions prevalent in the above countries are non-existent in India.

(iii) The freight earnings of a shipper is taxable under the Indian laws which inflates the actual ocean freight charges from Indian ports to the consuming markets.

(*d*) *Sales Tax.*—There are two types of sales tax *viz.* Central Sales Tax levied under the Central Sales Tax Act on sales in the course of inter-State sales, and the other local sales tax levied under the Sales Tax Acts of various State Governments on intra-State sales. When a mine-owner exports a commodity directly, the sale is not liable to tax, but where he sells it to another dealer who in turn exports it, the first sale attracts the provision of the sales tax, but the second does not. Method of taxation is complex and it varies from State to State.

(*e*) *Canal toll dues.*—Vessels carrying mineral ores have to pay to the Suez Canal Authorities canal toll dues which has the effect of inflating the actual ocean freight.

(*f*) *Local Taxes.*—Some of the mining areas have been brought under the purview of municipal taxation and gram panchayat rules and the mine owners have to pay municipal and panchayat taxes which are contributing to the high cost of production of manganese ore.

(*g*) *Royalty.*—International prices for manganese ore are still low. As the out-look for future is uncertain, the present rates of royalty do not appear to be justified and have brought about additional burden on the industry.

(*h*) *Disposition of mineral rights.*—(i) Large areas of manganese ore have been reserved in various States for exploitation in the public sector. Even though the State Governments have no plans to work the areas, the same are not being released to the private parties.

(ii) Some of the State Governments are granting renewal of leases for a period of 10 years only although under the Mines and Minerals (Regulation and Development) Act, 1957, maximum period of 20 years is provided. This will inhibit investment, planning and production.

(*i*) *Safety in mines and labour welfare.*—The need to provide for safety and walfare of workers in mines can hardly be ignored. At the same time it has to be ensured that such measures do not put undue strain on the mine-owners and obstruct their normal working. Some of the provisions in the Mines Act and Mines Rules could be oriented to suit the needs and working conditions at the manganese mines.

8.04. Recommendations.

(*a*) *Income-Tax.*—The following reliefs are recommended with regard to the levy of income tax on manganese mines :—

(*i*) Expenses incurred on prospecting and exploration of manganese mines to be treated as revenue expenditure.

(*ii*) Tax holiday for 3 years for new mines should be given.

(*iii*) Increase of the permissible depreciation allowance to 30% for mining machinery and equipment is recommended.

(*iv*) Expenses incurred on research and pilot plants in beneficiation or upgrading of ore is to be treated as revenue expenditure.

(*b*) *Sales Tax.*—The Committee recommends that the State Governments should be requested to exempt sales tax, central as well as local, on manganese ore intended for export. Alternatively, they should be requested to adopt the West Bengal system of taxation in the case of manganese ore.

(*c*) *Canal Toll dues.*—Efforts should be made to secure some relief from the above dues for manganese ore.

(*d*) *Local Taxes.*—The Committee recommends that the mining townships where suitable amenities, such as, facilities for hospitals, creches and canteens, conservancy, sanitation and other services are already provided by the mine-owners, should be exempted from gram-panchayat or municipal taxation. However, in the areas where adequate facilities are not provided by the mine-owners and the said services are provided by the local bodies, the levies may be imposed at the minimum rates provided under the Rules.

(*e*) *Royalty and Dead-rent.*—The Committee recommends the following rates of royalty on manganese ore :—

Dioxide ore (MnO_2 78% and above Fe 4% Maximum)	Rs. 10.00 per tonne.
45% Mn and above.	Rs. 4.00 per tonne.
35-45% Mn.	Rs. 2.00 per tonne.
Below 35% Mn.	Re. 1.00 per tonne.

It is further recommended that the dead-rent on manganese ore for the last 3 years should be waived in view of depressed market conditions. (This matter has already been referred to the Ministry of Commerce for necessary action in advance of the submission of the Report.)

Further, the Committee considers that the State Governments should be advised to collect arrears of dead-rent in instalments equal to the amount of royalty chargeable per tonne of ore on resumption of production. This will act as an inducement to the mine-owners to start mining operations.

With regard to the question of levy of royalty at the pit-head value of minerals, the Committee recommends that wherever departmental rules or instructions are not in accordance with the principle enunciated by the Mysore High Court, immediate steps should be taken by concerned State Government to modity or amend such rules and instructions wherever it is due.

(*f*) *The Manganese Mines Labour Welfare Fund.*—The legislation may not be enforced till manganese ore industry is fully rehabilitated and attains prosperity.

(*g*) *Disposition of mineral rights.*—(i) The Committee recommends that manganese bearing areas reserved for State exploitation should be released for exploitation in private sector if the State Governments do not have any definite plan of development and working the areas within a reasonable period from the date of reservation. Special consideration should also be given to granting leases of suitable areas to the ferro-manganese industry so that wherever possible it can depend upon its own captive mines for a uniform and regular supply of ore.

(ii) The Committee is of the view that the renewal of mining lease should not be granted for less than the maximum period provided under the Mines and Minerals (Regulation and Development) Act, 1957, unless a lessee himself applies for a shorter period. The renewal of the lease for a shorter period will inhibit investment, planning and production. (The Committee has already referred the recommendation to the Ministry of Commerce for necessary action.)

(iii) The Committee further recommends that applications for mining leases in the reserved area should also be considered for minerals other than the one for which it has been reserved provided that the working of the additional minerals in the area applied for will not affect the development of the remaining part of the reserved area.

(*h*) *Power of Revision of Central Government.*—(i) The Committee ecommends that the power of the Central Government in the matter of regulation and control of mining rights having been clearly defined in the Constitution, the State Governments should take steps to give immediate effect to the orders passed by the Central Government on applications made to them under the provisions of Mineral Concession Rules, 1960.

(ii) That a reasonable time limit for the disposal of revision applications should be provided in the Mineral Concession Rules, 1960 so that redress to aggreived parties is not unduly delayed or denied when it is most needed.

(*i*) *Labour and Safety.*—The requirements laid down under rule 33 of the Mines Rules regarding latrines and urinals in mines should not apply to manganese mines. Similarly rules 64 to 71 regarding provision of canteens in mines may be relaxed.

BIBLIOGRAPHY

(i) Mining Legislation and Taxation in Canada by A.M. Hussain, Deputy Mineral Economist, Indian Bureau of Mines.

(ii) Economics of Mineral Industries, Sully Mudd Series.

(iii) Area reports prepared in connection with the field work of the Committee on Manganese Ore.

(iv) Report of the Committee on Sales Tax, 1964.

(v) Various Indian Mining Laws and Act, Labour Laws, Income Tax Rules in India.

Table I : Comparative statement showing facilities under taxation laws in important countries

Country	Prospecting (Before development Stage is reached) Ascertaining the existence, location, extent, potentiality, quality etc.	Mining (Development) Shaft Sinking, Haulage, Ventilation etc.	Depletion	Depreciation
(1)	(2)	(3)	(4)	(5)
U.S.A.	Allowable against a profit up to $100,000 each year up to 4 years.	Allowable	5% to 23% on Gross Income provided it does not exceed of taxable income.	Depreciation per ton is equal to cost of the equipment *minus* salvage value of the equipment after production divided by production tonnage.
Canada . . .	(i) Allowable up to the profit of the Co. (ii) Balance if any, to be deferred and is deductible from the income of subsequent years.	100% expenses are depreciated.	Profit is not taxable up to 36 months. Hence for this period question does not arise. For further years 33⅓% of the net profit so long as the production continues.	Most mining equipments 30% (up to 36 months no profit is taxed. Hence during the period question of allowance does not arise).
S. Africa . . .	. .	Complete redemption of capital expenditure is allowed under the rules over the life of the mine. No separate depreciation or depletion allowance is allowed.		

Australia

(Other than Gold and Petroleum).

Deductions from the income of a year in which the exploration or prospecting expenditure is incurred are allowable, up to the amount of net income derived from a mining business or associated activities during the year. The carry forward of any unrecouped expenditure is also provided.

Capital expenditure on mining machinery and on the development may be deducted in 3 ways:—

(i) Capital expenditure incurred by a firm is allowable as a deduction over the estimated life of the mine. If the net income is insufficient to meet the deduction, the rules provide deduction of residual capital expenditure in subsequent years.

(ii) The firm may elect to deduct the capital expenditure on machinery and development during the year in which the expenditure was incurred.

(iii) The third alternative provides carmarking of a part of assessable income of a year for capital expenditure on mining machinery or on development of the mining property, thereby permitting the firm to deduct the amount appropriated, but not extended in that year. If during the ensuing 12 months such appropriated income is not wholly utilised, the residual appropriation is treated as assessable income of that period.

When the firm chooses to take no advantage of deductions allowable under special mining provisions in respect of the cost of plant, the following rates of depreciation are allowed on mining machinery etc.

Item	Percentage allowed	
	Prime cost method	Diminishing value method
Mining mchinery and Plant generally.	7½	11¼
Mechanical Coal Mining plant comprising cutters, loaders & shuttle cars.	12½	18¾
Buldozers	15	22½
Motor trucks-normal heavy duty.	20	30
Motor cars	15	22½
Tractors	15	22½
Mine cars	10	15
Skip in coal mines . .	17½	11¼
Rolling stock (trucks for carriage of coal).	2½	3¾

1	2	3	4	5	
			Conveyor units - Rubber belts.	15	22½
			Idlers	12½	18¾
			Motor, drive and structure of conveyor system.	7½	11¼
India . . .	Not allowable. (Expenses on prospecting up to pre-production stage is treated as capital expenditure).	The expenditure on shafts, adits and inclines, whether permanent or temporary is treated as of capital nature, and hence not allowable. Even royalty and rent is disallowed.	Not allowable.	Development Rebate and depreciation (only normal) is allowable. Extra Shift depreciation is not allowed.	

Table 2.—Rates of Local Sales Tax in various States on Minerals

Name of State/ Union Territory	RATES OF LOCAL SALES TAX AND STAGE OF LEVY ON			
	MICA		MINERAL ORES (METALLIC)	
	Rate of Tax	Whether single/ multi-point & stage of levy	Rate of Tax	Whether single/ multi-point & stage of levy
Andhra Pradesh	3%	S.P. last purchase	3% (Mn & Iron) 2%	S.P. last purchase other M.P.
Assam	4%	S.P. last sale	4%	S.P. last sale
Bihar	½%	M.P.	1/3%M.P. 4% S.P.	S.P. levy at last sale.
Delhi	5%	S.P. last sale	5%	S.P. last sale.
Gujarat	6½%	3% S.T. 3% G.S.T. ½% R.S.T.	6½%	3% S.T. 3% G.S.T. ½% R.S.T.
Himachal Pradesh	Nil	..	Nil	..
Jammu & Kashmir	Nil	..	Nil	..
Kerala	3%	M.P.	3%	M.P.
Madhya Pradesh	6%	S.P. First sale	6%	S.P.
Madras	2%	M.P.	2%	M.P.
Maharashtra	5½%	3% S.T. 2% G.S.T. ½% R.S.T.	5½%	3% S.T. 2% G.S.T. ½% R.S.T.
Manipur	3%	S.P. last sale	3%	S.P. last sale
Mysore	2%	M.P.	3%	S.P. last purchase.
Orissa	5%	S.P. last sale	5% (on manganese, lime-stone and dolomite. 2% when sold to man facturers in the state).	S. P. last sale
Punjab	6%	S.P. last sale	6%	S.P. last sale
Rajasthan	2%	S.P. last sale	1% iron ore 6% others	S.P. last sale.
Uttar Pradesh	2%	M.P.	2%	M.P.
West Bengal	5%	S.P. last sale	5%	S.P. last sale

S.T. Sales Tax.
G.S.T. General Sales Tax.
R.S.T. Retail Sales Tax.
S.P. Single point.
M.P. Multi point.

CHAPTER IX
MARKETING

9.00 Manganese ore plays a vital role in the steel making industry. It is for this reason that some of the major steel manufacturers have considered it necessary to develop captive sources for obtaining their requirements of manganes ore. The result is that only a limited free market is available to 'non-captive' sources *i.e.* such producers of manganese ore as are not tied to specific steel manufacturing interests. The steel mills which consume manganese ore generally do not purchase their requirements directly from the exporters of this ore. A few international agencies have monopolised the sales to steel producers and other consumers. They buy the ore from various sources and supply it to steel mills ensuring regular supply of right type of the ore at their furnaces. Their interest is not limited to sale of ore only; they also handle trade in the finished products produced by their customers, the steel mills. By virtue of comprehensive operations extending from supply of basic raw materials to marketing of ultimate products, these intermediate agencies have, in course of years, come to occupy a controlling position in the international market which enables them to direct and divert demand to and from one source of supply or the other in accordance with the special requirements of quality and time schedule of delivery of their customers. This monopolistic control tends to create uncertain conditions of demand in the producing countries. Another factor which contributes to complexity in the nature of manganese trade is the policy of stock-piling followed by certain users and Governments.

An attempt has been made in this chapter to estimate the demand of manganese ore by some major consuming countries with reference to sources of supply and the marketing practices followed in those countries.

World demand and supply

9.01 Out of the total world production of 16 million tons (1963) of manganese ore, slightly less than half is contributed by U.S.S.R. alone. Another 16% is accounted for by captive sources as listed in Table-I. India's share comes to about 6 per cent of the total, and the rest of the production is accounted for by 30 other countries. Table-II summarises the world production of manganese ore by countries during the years 1959-63.

With the exception of the U. S. S. R. the principal steel producing countries such as U. S. A., West Germany, Japan, U. K. and France have either little or no resources of manganese ore, and they depend on imports from other countries for their requirements. The total world demand of manganese ore has remained more or less stagnant at about 5 million tons per annum although production has increased by 25%, from about 13 million tons in 1957 to 16 million tons in 1963. This has resulted in excess of supplies leading to fall in prices. The other significant factor that has affected world trade is the emergence of captive

sources of supply. A number of large mines have been developed in manganese producing countries with financial and technical collaboration of the ultimate users and consumers of ore. These captive sources claim half of the total world trade. Assuming an average of half a million tonnes of exports as the share of the U.S.S.R. (the tonnage released by the Soviet Government for export to non communist countries varies from year to year) the amount of trade open to the free market where other countries could compete amounts to about 2 million tonnes per annum.

As manganese ore is mainly used in the manufacture of steel, a rough estimate could be made about the future demand of this mineral if the steel requirements of various countries were known. Table III gives country-wise production of steel in 1957 and 1963 and the estimated targets of production by the year 1975.

It has been calculated that consumption of manganese ore in U.S.A. amounts to about 14 to 16 lbs (about 8 Kg) per ton of steel. This figure includes consumption of ore in the form of ferro-alloy as also of raw ore used in the blast furnace. In India consumption of mangansese ore in steel industry is much higher, about 43 Kg (33 Kg in the shape of low grade ore and 10 Kg in the shape of metallurgical grade ore) per ton of steel. The consumption in other countries also varies, but it may be assumed to fall within these two limits.

To safeguard against any inflated projection of world demand of manganese ore, it would be desirable to make calculations based on United States consumption indicated above which is on the lower side. On this basis about 18,000 tons of ore may be required for the manufacture of one million ton of steel. On these calculations the total world demand of manganese ore may spurt up to about 10 million tons by 1975. In other words an annual increase of 4.5 lakh tons per annum in world trade may be expected. In arriving at these estimates, it has been kept in view that excepting U.S.S.R., none of the main world producers of steel possess any manganese ore in substantial quantities. Also, no techcnological advance resulting in the reduction of manganese ore consumption per ton of steel has been assumed. No account has been taken of the stock-piling policies of various Governments, as these are somewhat unpredictable and their effect is not easily measured.

It is difficult to forecast the share of various ore producing countries in the face of the likely increase in the world demand for the ore by the year 1975. At the same time it is felt that with the demand curve going upward, the production of the captive sources will also move up. However, it can reasonably be expected that the volume of trade open to the free market may increase from the present level of 2 million tons to 5 million tons per annum by 1975. The rise in demand, at any rate, is likely to provide greater opportunities to India to expand its exports.

Consuming Markets

9.02 The pattern of imports of manganese ore by consuming countries together with their sources of supply is discussed below.

U.S.A.

The U. S. A., with approximately half the world steel capacity, is the largest consumer of manganese ore accounting for about 1/8th of world production. The domestic production of manganese ore being very small, the bulk of the demand of about 2 million tons is met by imports.

During the pre-war years U. S. A. imported manganese ore mostly from U. S. S. R. and Ghana. After the war, India, South Africa and Brazil became the major suppliers. In 1957 the U. S. A. imported as much as 7.9 lakh tons or about 26% of its total imports, from India alone. India's share, however, declined to 8% in 1963. The factors responsible for this steep fall were :

(i) Decline in production of manganese ore in India.

(ii) High end-cost of Indian ore on account of distance and limited port facilities.

(iii) Technological developments in the U. S. Steel industry.

(iv) Emergence of new mining areas and captive sources of supply particularly in Brazil where the U. S. steel industry has made large investments and provided technical know-how. The U.S. Steel Industry acting in collaboration with U. K. and France also helped to develop mines in Gabon. The result of these new developments was that the pattern of import changed considerably. This will be clear from the following Table:

Imports of Manganese Ore into the U. S. A. ('000 tonnes)

Exporting Country	1959		1963		1964	
	Qty	% Share	Qty.	% Share	Qty.	% Share
Brazil	1,048·1	44·8	802·7	42·1	495·0	26·5
India	381·4	16·3	153·5	8.0	199·3	10·6
Ghana	240·2	10·3	93·5	4·9	109·3	5·9
Mexico	183·8	7·9	133·9	7·0	139·0	7·4
S. Africa	173·9	7·4	109·3	5·7	172·9	9·2
Congo	93·6	4·0	213·5	11·2	151·5	8·1
Gabon	..	..	200·5	10·5	193·0	10·3
Br. Guiana	..	..	70·5	3·7	55·2	2·9
Morocco	..	..	34·6	1·8	39·1	2·1
W. Africa	*	..	*	..	146·2	13·1
Others	218·6	9·3	97·5	5·1	72·4	3·9
TOTAL	2,339·6	100·0	1909·5	100·0	1872·9	100·0

*Included in 'others'

The increase in India's share of imports by U.S.A. from 8% in 1963 to 10.6% in 1964 was partly the result of fall in out-put of manganese ore in Brazil which is the principal source for U.S.A. Besides this, the second barter also helped to give a fillip to the Indian exports for a short while. Since the close of 1963 there has been a slight upward trend in the manganese ore prices due to increased demand for ore needed for expanded steel making capacity in the world. The preference of U.S.A. for imports from African countries mainly for reasons of lower transport costs continues. In the immediate future there is no liklihood of any substantial increase in the U. S. Imports of Indian manganese ore with the present level of steel production. However, viewed from a long term perspective the U. S. demand for manganese ore by 1975 is estimated to grow by 50% with a possibility of larger imports from India.

West Germany

West Germany is the second largest importer of manganese ore next only to U. S. A. As there is practically no local production, all her requirements of this ore are met by imports. These imports have shown large increase in the recent years as will be seen from the following table :

(In '000 tons)

Year	*Imports*
1959	303
1960	342
1961	496
1962	518
1963	731
1964	764

For the last 4-5 years, the rate of increase has been particularly marked. On the basis of steel production forecasts, it is expected that the imports of manganese ore will register a further increase of about one million ton by 1975.

The imports of manganese ore into West Germany are largely drawn from South Africa, Gabon, Ghana, Congo, U.S.S.R. and India. The country-wise imports during 1962-64 have been as under:

(in '000 tons)

S. No.	Country	1962	1963	1964
1	South Africa	135	237	170
2	India	103	125	130
3	Gabon	..	73	102
4	U.S.S.R.	65	72	6
5	Ghana	67	60	51
6	Congo	39	50	89
7	Brazil	..	32	56
8	Ivory Coast	14	29	50
9	Hungary	7	27	59
10	U.A.R.	21	..	16

From this statement it will be seen that the imports from South Africa have shown a steep rise from 15,717 tons in 1959 to 237,378 tons in 1963. Gabon entered the German market only recently and has emerged as the leading exporter of manganese ore to West Germany. Other recent arrivals in the West German market are Ghana, Brazil and Morocco who have sold substantial quantities. The imports from U.S.S.R. have also been showing up during last few years.

India's exports to West Germany have recorded slight increase. As against the approximate figure of 103,000 tons in 1962 and 125,000 tons in 1963, the exports during 1964 were estimated at about 130,000 tons consisting largely of medium and low grade ore. As the aggregate German imports of manganese ore will increase with the growth of steel production, it is advisable to explore this market with a view to stepping up exports from India. Unfortunately, the incidence of high freight costs acts as a drag on larger shipments from India. India has a special interest in developing this market as it provides a major outlet for the export of low grade manganese ore.

France

As there is no internal production of the ore, almost all the requirements of France are met by imports. The following statement contains the figures for French imports, as drawn from various sources during the last five years:

(Quantity in '000 tons)

From	1960	1961	1962	1963	1964
U.S.S.R. . . .	11	90	125	113	100
Morocco . . .	290	302	272	228	223
South Africa . . .	170	139	231	200	220
Gabon . . .	..	..	..	120	183
India	134	77	40	14	18
Brazil	..	36	19	19	25
Total Including other countries.	778	670	717	712	791

It will be observed that while there has been a significant increase in the total volume of import of manganese ore into the country, imports from India have shrunk to a remarkably low level. From 134,000 tons in 1960 they droppd to nearly 14,000 tons in 1963. On the other hand, imports from Gabon reached a record level of 120,000 tons in 1963.

Among the various factors which led to decline of imports from India, the most important has been the emergence of new sources of supply

in close proximity to France and the entry of U.S.S.R. in this market. There has been a large investment of French capital in manganese mines in Gabon which has now come up as a principal exporter of manganese ore. South Africa and Morocco are the other important exporters, both of them having freight advantage over India. The French monopoly Societe-du-manganese which is the main import organisation of the country has also developed its sources of supply in West Africa. All these reasons have contributed to make Indian ore highly uneconomic. It has not been possible for India to make much headway in securing an assured market in France.

To retrieve the lost position, vigorous efforts will have to be made to make the Indian manganese ore more competitive and restore the confidence of the importers both in regard to quality and regularity of supplies.

United Kingdom

United Kingdom is the fourth largest importer of managnese ore in the world. Like, U. S. A., West Germany and France, she also imports all her requirements as there is no production of ore within the country. The imports during the last few years have been as under:

Year	Quantity (in '000 tons)
1959	297
1960	523
1961	472
1962	344
1963	314
1964	526

In the past, large quantities of manganese ore were imported mainly from Brazil and U. A. R. ; but recently imports from these countries have declined. At present, large quantities of manganese ore are imported from U.S.S.R., South Africa, India and Ghana.

The country-wise imports for the years 1962, 1963 and 1964 are given below :

(In '000 tons)

Country	1962	1963	1964
U.S.S.R.	80	108	153
South Africa	95	94	120
India	99	73	67
Ghana	26	27	39
China	2	3	N.A.
Morocco	2	3	N.A.

9—1 I. B. M. (N. D.)/65

It will be seen from the above table that in spite of the large increase in the overall volume of manganese ore imports into United Kingdom during 1964, the imports from India declined to a low level although traditionally Indian ore has been the main feeder of the furnaces in that country. The main reason for decline in imports from India is that supplies have tended to be irregular on account of transport difficulties and delivery schedule being too protracted. On the contrary, supplies from South Africa are more regular and dependable with better shipping facilities. Unless, therefore, concerted efforts are made to overcome these difficulties the U. K. imports of Indian ore may well look to other dependable markets. The U. K. imports both high and low grades of manganese ore, the imports of high grade ore are mainly from U.S.S.R. and of low grade from South Africa. India being a producer of high quality ore, could look forward to an increased share in the trade only if it is in a position to supply low impurity ore with guaranteed granulation on dependable delivery terms.

Japan

Japan is the largest importer of manganese ore in Asia. Her internal production being hardly of the order of 3 lakh tons, she has to depend for the bulk of her requirements on imports from abroad. The following table shows the import of manganese ore into Japan during the last few years :

Year	Quantity (in '000 tons)
1958	170
1959	274
1960	238
1961	263
1962	317
1963	368
1964	559

It will be observed from the above table that Japanese imports have been steadily increasing as a result of the expansion of the steel industry.

India has been the principal supplier of manganese ore to Japan as will be seen from the following table :

('000 tons)

	Country	1963	1964
1.	India	165·8	340·1
2.	South Africa	55·4	18·0
3.	U.S.S.R.	32.3	69·1
4.	Ghana	19·7	8·9
5.	Australia	17·2	20·2
6.	China (Mainland)	9·5	—
7.	Fiji	9·2	—
8.	Mozambique	9·0	4·9
9.	Gabon	29·0	5·1
10.	Indonesia	7·8	—
	TOTAL (including others)	367·8	558.9

In addition to above, Japan also imports large tonnage of ferruginous manganese ore. During 1963-64, she imported approximately 2 lakh tons of this grade of ore from India. The other source of supply of this grade of ore is South Africa but supplies from that country being limited, India has almost a monopoly for this grade of ore.

Keeping in view Japan's target of steel production and her imports during the last few years, it is estimated that by the end of 1965 her imports may reach a level of 6 lakh tons of high grade ore. Against this, contracts for the supply of 3.5 lakh tons have already been concluded. Brazil, New Hebrites and Australia are new entrants in this market and imports from these countries have been progressively increasing during the last few years. India may not be able to sell more than 100,000 tons high grade ore and approximately 4 lakh tons of ferruginous ore to Japan during 1965.

East European Countries

Among the East European countries, Bulgaria and Rumania are self-sufficient in manganese ore and there has been no import of this commodity into these countries. Manganese imports of other East European countries are given below :

(lakh tonnes)

Country	1959	1963	1964
Czechoslovakia	1·42	2·39	..
East Germany	0·88	0·87	..
Poland	*3·10	3·04	3·80
Yugoslavia	0·33	0·36	

(*Relates to 1960)

Bulk of the imports of manganese ore into these countries is drawn from U. S. S. R. except in the case of Yugoslavia. India has been the second largest supplier of manganese ore to these countries in recent years. Yugoslavia gets the major portion of her imports from India and Morocco. There has been a steady increase in India's exports of manganese ore to Czechoslovakia and Poland, while exports to East Germany have been on the decline. Details regarding India's exports of manganese ore to East European countries are given in the table below :

(Quantity : Lakh Tonnes)
(Value : Rs. Million)

	1960—61		1961—62		1962—63		1963—64		1964—65	
	Q	V	Q	V	Q	V	Q	V	Q	V
Czechoslovakia	0·53	7·04	0·30	3·74	0·71	8·08	0·70	7·48	0·85	8·00
East Germany	0·12	1·86	0·05	0·68	..	..	0·01	0·21	..	..
Poland . .	0·12	1·73	0·17	1·24	0·26	3·42	0·41	4·77	0·55	6·74
Yugoslavia .	0·16	2·30	0·25	3·88	0·29	3·90	0·28	3·30	0·20	2·85

India has entered into trade agreements with most of the countries of East Europe. It has firm commitments for export of manganese ore as under but within the frame work of the Trade agreements :—

(Rs. in lakhs)

Country	1964	1965	1966
Poland	80	80	80
Yugoslavia	60	50	N.A.
Czechoslovakia	110	110	110

The quantities shown against the ceiling have, however, not yet been lifted.

According to the present indications the total imports of manganese ore into Poland may go up at the rate of 10% per annum. The requirements of Polish industry are for low phosphorus ore which they are presently importing from Morocco. Owing to the limited resources of low phos. manganese ore in India and our commitments in the West European and American markets, there is not much scope for increasing India's exports in spite of the expansion of Polish demand. There has been a rise in the demand for Indian manganese ore from Czechoslovakia and it is anticipated that the future requirements of that country may be stabilised at 1.50 lakh tons per annum.

Trading Mechanism

Trading mechanism for manganese ore varies from country to country. Different patterns have crystallised as a result of the peculiar conditions and experience of various countries over a period of time. The following trading systems are at present prevalent in the important manganese importing countries.

U.S.A.—U. S. A. occupies first place among the steel producing countries of the world. The consumers in U.S.A., steel mills, seldom make direct purchases. One of the main reasons for their procuring supplies through traders in ore is the financial accommodation provided by these intermediaries. Some of these trading houses make even long term advances to the users of manganese and also provide other services. The number of such trading houses in U.S.A. is limited to about a dozen firms.

These intermediate agencies take upon themselves certain obligations relating to the supply of the raw material in conformity with the specifications required by the buyers. This is accomplished by their making purchases from different sources of supply and blending ores in appropriate proportions to obtain the requisite grade.

Japan.—There are two types of purchasing agencies *viz.* Ferro Producers and the Steel Mills. The Ferro Producers whose demand is mostly for high and selected grades of ore obtain their requirements through their own association. The Steel Mills, on the other hand, are mainly interested in the import of low grade ore and purchases are made individually by the Steel Mills through their own trading houses.

The imports of manganese ore in Japan are subject to allotment quota which is fixed by the Japanese Government periodically. Within the allotted quota the Ferro Alloy Association is free to negotiate business and arrange imports. A similar quota system exists also in respect of low grade ore.

Among the various trading houses which negotiate business for low grade and ferruginous ore for supply to Steel Mills there is an intense competition which helps to keep the prices low.

Western Europe.—In many of the West European countries centralised purchasing agencies have come into existence. In the U. K. BISCO (Ore) imports manganese ore on behalf of Steel Mills and the Ferro Producers in that country. Similarly, in France, Societe du manganese is a semi-state monopoly for import of manganese ore. The demands are pooled and met by the purchasing agencies collectively for all consumers. This places the buyer of ore in a relatively advantageous position with reference to sellers because *inter-se* competition among the former is practically eliminated.

Eastern Europe.—These are countries of controlled economy and all the imports are regulated through single state monopolies. This system, while giving the advantage to the importing country works to the disadvantage of the exporter, who are left with practically no bargaining power.

Pattern of Trade in India

Prior to the decontrol of manganese ore in October, 1962, the exports were regulated on a quota basis. Yearly quota was allotted to each established shipper who was free to export manganese ore to the extent of the allotted quantities. After the quota system was abolished, each shipper became free to export any quantity and quality of ore. The system has proved to be a great handicap in a buyers market as a large number of small exporters are hardly in a position to negotiate business effectively with a few specialised importing agencies. Their resources being meagre, most of them are also not in a position to maintain quality and delivery schedules.

The system of barters which was evolved to create interest in the buyers for exporting goods against the import of manganese ore, undoubtedly gave considerable stimulus to the exports of manganese ore as would be observed from the following table :

Qty. in Metric Tons (Including Goa)
Value in Rs. Lakhs

Year	CASH		BARTER		TOTAL	
	Qty.	Value	Qty.	Value	Qty.	Value
1961 . .	5,46,589	601·89	5,67,042	590·80	11,13,631	1,192·69
1962 . .	5,42,888	524·64	3,55,303	374·41	8,98,191	899·05
1963 . .	4,30,729	403·15	5,01,235	390·52	9,31,964	793·67
1964 . .	4,40,063	374·40	11,28,854	979·39	15,68,917	1,353·79

However, by its very nature this system could not be extended for an indefinite period. On the other hand, the disparity between the internal cost of production in India and the international prices, the multiplicity of small exporters and unhealthy *inter-se* competition and other similar factors continue to operate against the prospects of Indian exports. In addition, as stated in other chapters of the report, discovery of new deposits and development of mines in countries near the consuming centres has further affected the competitive position of Indian ore in the international market.

It is to remedy some of these basic weaknesses of the Indian manganese ore trade that Government have taken a decision to canalise exports through two public sector agencies:

(a) Minerals and Metals Trading Corporation of India Ltd. in respect of all manganese ore (other than the ores produced by the Manganese Ore (India) Ltd. and

(b) Manganese Ore (India) Ltd. in respect of ores produced by the Company (or acquired by the Company in the course of its normal business operations) for which the Company can arrange sales to consumers abroad.

Conclusions

1. The annual world market of manganese ore is likely to increase to 10 million tons by 1975 against the present level of 5 million tons. Captive sources of supply developed by the principal consumers of manganese ore can be expected to meet 50 percent of this demand leaving a "free demand" of about 5 million tons per annum available to mine-owners and suppliers of mangnese not committed to particular users.

2. The figure of 5 million tons of "free demand" is considered substantial especially when compared to the present volume of trade *viz.* 2 million tons per annum. As India is one of the largest producers of manganese ore among "non-captive" sources, it can reasonably hope for a larger share in total world exports provided the present production is expanded to produce the requisite quantities with due regard to the prime need for reducing costs. The increased world demand however, need not necessarily imply any significant rise in international prices as the major portion of production will be derived from those sources where costs of production are low and better port facilities are available.

3. Under the existing pattern of trade, the demand of ore is pooled and met by a few intermediate ore purchasing agencies collectively for all consumers. This places the buyer of ore in a relatively advantageous position with reference to sellers, because while *inter-se* competition among the former is practically eliminated the suppliers continue to operate on an individual basis. In India, apart from the disparity between the uneconomic costs of production and the international prices, the multiplicity of small exporters and other similar factors continue to operate against the prospects of Indian exports.

Recommendations

The Committee feels that with a view to maximising exports, it is desirable to canalise the exports of manganese through one or two central agencies which by means of carefully coordinated operations can obtain the best prices and terms for Indian manganese ore. The Committee notes that the Government of India have taken a decision to canalise exports of manganese ore through (i) Minerals and Metals Trading Corporation of India Ltd. (ii) Manganese Ore (India) Ltd. which are both public sector undertakings. The working of the new arrangements should be carefully reviewed from time to time from the point of view of significant gains in India's export trade and foreign exchange earnings. The Committee also recommends that M. M. T. C. being the only agency for purchasing ore raised by small mine owners, it should take on itself an active role in providing technical and wherever possible managerial and financial assistance for developing and modernising their mines, with a view to maintaining quality or grade and reducing costs of production.

Table I : Production of Manganese ore from captive sources

(In short tons)

Country	Per cent Mn.	1953-57 average	1958	1959	1960	1961	1962	1963
Brazil . . .	38—50	404,469	972,413	1,138,649	1,101,387	1,101,669	1,290,461	1,320,000
British Guiana . .	40—42	..	..	..	137,454	216,203	303,636	157,331
Gabon . . .	50—52	..	..	..	..	..	224,038	701,716
Morocco . . .	35—50	475,317	452,041	518,711	532,508	692,512	517,377	396,283
TOTAL .		879,926	1,424,454	1,657,360	1,771,349	2,010,384	2,335,512	2,575,330
WORLD. TOTAL .		12,487,000	13,671,000	14,275,000	15,027,000	15,073,000	15,764,000	16,090,000
% of World Production		7·05	10·42	11·61	11·79	13·34	14·81	16·00

Source : Minerals and Metals Trading Corporation of India Ltd.

Table II : World Production of Manganese ore by Countries

(In short tons)

Country	'Per cent' Mn(3)	1954—58 (Average)	1959	1960	1961	1962	1963
North America :							
Costa Rica (Expts.)	35+	..	..	..	..	..	661
Cuba	36—50+	209,604(4)	58,806(4)	(5)17,644	(3-4)46,000	(3)83,000	(3)83,400
Mexico (3)	44—46	190,800	181,900	171,400	155,900	184,900	189,300
Panama	..	3,321(6)	..	..	..	..	..
United States (Shipments)	35+	306,352	229,199	80,021	46,088	24,758	10,622
TOTAL (3)		710,077	469,905	269,100	248,000	292,700	284,000
South America :							
Argentina	30—40	19,174	21,358	24,251	(3)22,000	11,253	(3)11,000
Bolivia (Exports)	..	..	..	..	53	291	
Brazil	38—50	548,081	1,138,649	1,101,387	1,120,336	1,290,461	(3)1,320,000
British Guiana	40—42	..	..	123,811	216,203	303,636	157,331
Chile	40—50	48,646	42,744	50,594	35,012	47,578	51,235
Peru	40+	9,473	2,803	1,655	3,879	7,403	1,089
Venezula	38+	(7)17,429	3,955	..	..	..	..
TOTAL		642,803	1,209,509	1,301,698	1,397,483	1,660,622	(3)1,540,700

10—1 I. B. M. (N. D.)/65

Table II : World Production of Manganese ore by Countries—*Contd.*

Country	'Percent' Mn(3)	1954—58 (Average)	1959	1960	1961	1962	1963
Europe :							
Bulgaria	30+	62,189	28,700	27,600	40,800	38,600	42,400
Greece	35+	18,826	38,581	34,410	31,195	(3)33,100	(3) 22,000
Hungary	30—	146,250	170,086	135,888	137,610	142,447	(3) 132,300
Italy	30—	53,969	57,520	54,561	54,196	49,053	49,920
Portugal	35+	6,009	7,703	8,197	12,492	12,666	(3) 20,500
Rumania	35	278,628	216,910	192,872	227,076	208,337	(3) 220,500
Spain	30+	41,975	44,924	24,586	17,092	14,101	16,631
U.S.S.R (8)	..	5,463,900	6,030,300	6,472,800	6,583,000	7,057,000	(3) 7,385,000
Yugoslavia	30+	6,159	8,911	14,676	15,595	16,357	8,964
TOTAL (1)		6,077,905	6,653,635	6,965,590	7,119,056	7,571,661	7,898,000
Asia.							
Burma	42+	1,539	606	324	196	213	(3) 220
China (3)	30+	556,000	1,100,000	1,320,000	880,000	880,000	1,100,000
Goa	32—50	147,498	83,584	118,195	109,790	96,732	(4) 115,290
India	35+	1,712,337	1,298,472	1,321,411	1,355,868	1,306,914	1,184,983
Indonesia	35—49	58,495	47,172	12,026	14,007	5,460	(3) 1,700
Iran (9)	30+	4,752	2,425	8,488	2,315	2,205	(3) 1,100
Japan	32—40	272,289	383,699	357,131	335,236	340,162	305,506

Korea Rep. of	30—48	2,312	496	1,521	1,518	1,105	4,580
Malaya	30+	..	..	3,222	7,130	341	7,696
Pakistan	42+	..	32	327	386	15	..
Philipines	35—51	17,253	38,365	19,159	20,996	13,160	6,769
Thailand	40+	(7) 645	452	582	588	3,194	7,186
Turkey	30—50	5,292	39,341	31,112	33,069	23,422	6,949
TOTAL (3)		2,778,000	2,995,000	3,193,000	2,761,000	2,673,000	2,742,000
Africa :							
Angola	38—48	31,483	39,314	25,728	22,695	9,115	..
Bechuanaland	30+	(6) 7,228	20,138	25,032	31,737	26,458	11,878
Congo Republic of (formerly Belgian)	48+	414,771	425,694	420,671	350,208	329,568	348,547
Ethopia	51	..	1,455	10,202	7,716	6,614	..
Gabon Republic	50—52	..	..	..	..	224,038	701,716
Ghana (Exports) (10)	48	622,902	577,694	600,261	431,282	513,622	434,410
Ivory Coast	38+	..	..	67,917	137,502	139,265	153,291
Morocco	35—50	470,829	518,711	532,508	629,512	517,377	369,283
Northern Rhodesia	30+	33,425	60,297	59,299	56,901	51,501	38,856
Southern Rhodesia	30+	1,292	2,126	16,676	205	7,977	
S. Africa Republic	30+	784,525	1,069,202	1,316,132	1,562,729	1,614,599	1,441,503
South West Africa	45+	65,184	49,442	67,439	50,295	..	..
Sudan (3)	36—44	(7) 7,700	440	..	..	..	..
U.A.R.(Egypt)(11)	35+	15,504	67,318	22,046	2,272	42,577	53,628
TOTAL		2,454,843	2,831,831	3,148,911	3,283,054	3,482,711	3,553,112

Table II : World Production of Manganese ore by Countries—*Concld.*

Country	'Percent' Mn(3)	1954—58 (Average)	1959	1960	1961	1962	1963
Oceania :							
Australia	45—48	60,827	100,768	67,923	97,901	77,851	(3)40,500
Fiji	40+	23,001	14,566	13,073	3,869	1,202	3,621
New Hebrides	52—55	..	..	..	5,060	21,859	28,016
New Zealand	48+	155	114	134	..	..	..
Papua	46	8	..	54	2	..	4
TOTAL		83,991	115,448	81,184	106,832	100,912	(3) 72,100
(1) WORLD TOTAL (ESTIMATES)		12,748,000	14,275,000	14,959,000	14,915,000	15,782,000	16,090,000

FOOT NOTES :

1. Czechoslovakia and Sweden report production of mangane ore (approximately 13 to 17 % manganese content), but since the manganese content averages substantially less than 30 per cent, the output is not included in this table. Czechoslovakia averages annually 165,000 short tons and Sweden appıoxmately 11,000 tons the last 5 years.
2. This table incorporates some revisions. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
3. Estimate
4. Exports.
5. United States Imports.
6. Average annual production 1957-58.
7. Average annual production 1956-58.
8. Grade unstated. SOURCE : The industry of the U. S. S. R. Central Statistical Administration (Moscow).
9. Year ending March 20 of the year following that stated.
10. Dry weight.
11. In addition to high grade ore shown in the table, Egypt produced the following tonnages of less than 30 per cent manganese content ; 1954-58 (average)—154,816 ; 1959—72,752; 1960—282,191; 1961—304,663 and 1962—162,102.

Table III : Steel Production in important Countries and Estimated Trend for 1972-75

(Quantity in '000 tons)

S.No.	Country	1957(a)	1964	1972-75(a)
1	United States of America . . .	97,178	113,302	1,45,000
2	U.S.S.R.	49,337	83,652	1,13,000
3	Japan	12,627	39,140	35,000
4	United Kingdom	19,116	26,230	32,000
5	West Germany	21,097	36,804	36,000
6	France	12,770	19,480	25,000
7	Italy	6,733	9,624	16,000
8	Canada	6,689	8,200	12,800
9	India	3,619	5,900	28,000
10	Czechoslovakia	4,814	8,242	10,700
11	Poland	4,932	8,450	21,500
12	All others	58,003	65,976	1,65,700
	TOTAL INCLUDING OTHERS . .	2,96,915	425,000*	6,30,700

NOTE :—Source for 1957 figures and 1972-75 estimates is the 'Long term trend and problems of European Steel Industry, prepared by the Economic Commission for Europe.

*Estimated.

Table IV :—Exports of Manganese ore against Cash/Barter

(Quantity in tons
Value in Rs. lakhs)

Period Year	S.T.C./M.M.T.C. (Cash)		Private Sector (Cash)		Total Cash		Total Barter		Total India	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1959 . . .	2,71,721	363·84	5,16,643	641·28	7,88,364	1,005·12	1,92,193	256·84	9,80,557	1,261·96
1960—61 . .	210,895	294·09	2,97,559	319·50	5,08,454	613·59	6,53,856	779·65	11,62,310	1,393·24
1961—62 . .	1,46,482	175·44	2,61,297	304·42	4,07,779	479·86	5,51,585	553·10	9,59,364	1,032·96
1962—63 . .	1,56,913	186·59	2,63,602	260·11	4,20,515	446·70	3,22,932	329·78	7,43,447	776·48
1963—64 . .	41,504	41·12	3,04,402	310.37	3,45,906	351·49	5,97,645	454·25	9,43,551	805·74
1964—65 . .	1,21,389	88·99	2,23,897	169·10	3,45,286	258·09	12,34,154	1,056·66	15,79,440	1,314·75

CHAPTER X

CONCLUSIONS AND RECOMMENDATIONS

1. World Resources of Manganese Ore—A Survey of Reserves in India and other countries

CONCLUSIONS :

(i) Almost seventy per cent of the world resources of manganese ore is accounted for by the USSR and the remaining thirty per cent is distributed among various other countries chiefly India, Brazil, Ghana, Union of South Africa, Union of Gabon and Morocco.

(ii) During recent years, large scale prospecting operations have been carried out in some of these countries which have resulted in considerable additions to the known resources of manganese ore. According to the Mining Journal Annual Review—1963, the manganese ore resources of the USSR, were estimated at 2,000 million tons in 1961. This represents a great advance over the 1956 estimate of 550 million tons of 28-50% Mn.

The resources at Amapa, Brazil are estimated at 14 million tons of ore with 45 to 47% Mn. Besides, additional reserves are reported to have been discovered recently underlying the known deposits at Amapa mines which is the largest producer of manganese in the Western hemisphere. The Bethlehem Steel (U.S.A.) are associated with development and mining of these deposits.

Very promising manganese ore deposits have recently been discovered at Maonda, Gabon. These deposits are among the largest and richest in the world. Reserves of the order of 200 million tons of ore of 50% Mn. have been estimated. These deposits are being explored and exploited by the Compagnie Minerie de l'ogone (Comilog) in which U.S. Steel has a major interest.

(iii) All major steel producing countries of the world excepting U.S.S.R. and China continue to have either very poor or no resources of manganese ore.

(iv) The United States of America has several large deposits of low grade refractory material containing sizeable quantities of manganese which could be recovered only under favourable conditions of improved technology, higher prices or both.

RECOMMENDATIONS :

(i) Intensive exploration of manganese bearing areas in India is necessary for proving additional reserves. Government should accord high priority to exploration of manganese ore through the agencies

of the Geological Survey of India, Indian Bureau of Mines and State Government's departments of geology in this respect.

(ii) Large scale mapping followed by exploratory drilling is the well established procedure. Geo-chemical and Geo-physical survey techniques should be pressed into service where possible. Magnetic and gravity surveys conducted by the Geological Survey of India have yielded good results in Madhya Pradesh and Andhra Pradesh. It will be useful if the results of these surveys could be made available to interested prospectors and mining interests through the medium of published monographs.

(iii) From the point of view of economics of exports, it will be necessary to accord priority to exploration of those deposits which are located near the sea coast, as for example in Mysore (North Kanara) and Goa. To meet the indigenous requirements of ferro-manganese producers and the steel plants, similarly, particular attention would have to be given to deposits in close proximity to these plants. Some of these 'near plant' deposits could serve, with advantage to industry, as a captive source for the ferromanganese producers and steel mills.

2. Physical and Chemical Characteristics of Manganese Ores

CONCLUSIONS :

(i) Indian manganese ores are fairly hard, lumpy and easily reducible; these characteristics are favourable for smelting ferro-manganese.

(ii) Indian ores have, however, low Mn : Fe ratio of generally 6:1 as compared to Caucasian ore ratio of 50:1, Ghana 10:1 and Brazil 10:1. This is below specifications for the manufacture of ferro-manganese, which requires a high Mn-Fe ratio.

(iii) High phosphorus ores especially of Andhra Pradesh and Panch Mahals are also not very suitable for ferro-manganese industry.

(iv) In view of these characteristics of ores, blending of ores of various grades is a necessity.

RECOMMENDATIONS :

(i) There is ample scope for blending ores of different types to produce standard mixtures with acceptable percentages of various constituents, particularly manganese, iron and phosphorous. Blending operations if they are to be productive of optimum results, would require careful control of the grade of ingredients *i.e.*, different types of ores which go into the final mixture. This will be greatly facilitated if the entire operation is carried out by or under the direction of an expert agency which has control of or access to the different grades of ores.

(ii) Blending of ores should be done at a few selected points having regard to the extent and quality of production from particular manganese producing areas. Variation in composition of the ores is no bar to blending. In fact such variations within a certain range provide scope for ingenuity of the "blender". It is possible to mix

ores for production of a few standard grades acceptable to the foreign buyers. Some of the well known grades are 'Oriental' and 'Standard' mixture of MOIL and CPMO, 'Sandur A' and 'Sandur B' of Messers. Sandur Manganese and Iron Ore (P) Ltd.

(iii) There is great scope for beneficiation of ores which deserves more attention than hithertofore. Full details of the problems of beneficiation have been discussed under Chapter V.

(iv) There is need for intensive research to achieve reduction of phosphorus content of ores. The Indian Bureau of Mines should be asked to pay special attention to this matter and undertake further research. The National Metallurgical Laboratory has recently commissioned an integrated pilot plant on the beneficiation of low grade manganese ores at a capital cost of Rs. 35.00 lakhs. The N.M.L. could be requested to conduct studies into the methods of reducing phosphorus.

3. Beneficiation and Blending

CONCLUSIONS :

(i) Almost all important manganese ore producing countries of the world such as Brazil, Gabon, Ghana etc. undertake beneficiation processes which do not result in the production of concentrate fines. Coarse concentrates do not require agglomeration.

(ii) In Brazil, the preparation of ore consists of crushing, screening, washing and dewatering. Almost a similar process is followed in Gabon. Ores are washed to remove clay impurities in Ghana.

(iii) Russian ores require crushing, washing and agglomeration of fine concentrates. At times flotation, jigging and tabling is also employed.

(iv) In India the main operations are breaking and hand sorting. Jigging and washing are employed on a limited scale. There is only one heavy media separation plant in the country.

(v) From the point of view of beneficiation, the Indian ores have broadly been divided into four groups *i.e.*, simple, ferruginous, garnetiferous and complex. From the work carried out by the National Metallurgical Laboratory and the Indian Bureau of Mines, it is seen that only a small proportion of the manganese ores in India can be classified under simple ore requiring comparatively simple treatment like gravity concentration etc. There is a preponderance of ferruginous and garnetiferous ores and these require more elaborate and costly beneficiation plants. From the data of research work, however, it can be seen that most of the ores are amenable to beneficiation and the concentrates obtained are generally suitable for ferro-manganese production. The concentrates of the complex ores would need blending with other suitable concentrates to meet the specifications.

RECOMMENDATIONS :

(i) The problem of beneficiation in India has to be viewed in two ways (a) production of beneficiated coarse concentrates (b) production of concentrate fines and their agglomeration.

(ii) The former should receive immediate attention. The lump ores could be upgraded to a considerable extent by crushing, screening, washing and jigging. Such ores could be carefully blended with ores from other regions to produce clean standard grade ore required by the foreign buyers. This may not be feasible in the present state of affairs of the industry where the bulk of production is accounted for by a very large number of producers and exports are similarly handled by numerous exporters. In the circumstances, beneficiation of ores and expert blending of different ores could be successfully undertaken only by a co-operative organisation of producers and exporters of manganese or any other centralised agency which would have resources, organisation and expertise to handle ores from a large number of mines and adopt beneficiation techniques at reasonable cost without affecting the economics of export. It should be possible to set up in North Kanara, Orissa, Madhya Pradesh and Maharashtra a few relatively simple beneficiation units employing crushing, screening, jigging and washing techniques.

(iii) Heavy media separation holds considerable promise. It can serve as a pre-concentration unit to reject waste rock from the run of mine ore and deliver an enriched sink for further concentration. It thus allows for indiscriminate mining without any laborious selection. By discarding the waste rock at an early stage, the mill gets an enriched feed and, for the same throughput, a larger production is obtained. This process brings about a greater reduction in the amount of material passing through the various crushing, grinding and concentration plants. It is applicable only to those areas in which a fair amount of mineral is liberated at coarse size. The minerals should also be separable at specific gravity less than 3·3. Manganese minerals of India generally possess a specific gravity of about 4 and therefore can be concentrated by heavy media separation from quartzitic or schistose rocks. The Committee recommends installation of a few more heavy media separation plants in Madhya Pradesh and Maharashtra region.

(iv) It may be possible to blend North Kanara ores with Panchmahal ores, and Orissa ores with Srikakulam ores. Due to wide variations in the composition of ores from one mine to the other, it may also be possible to blend ore locally in accordance with a carefully drawn up detailed scheme.

(v) As has already been stated above, different categories of manganese ores of India are amenable to beneficiation. The beneficiated ore, *i.e.* concentrate, is in the form of powder which would have to be agglomerated before use. Concentrates of complex ores would need careful blending. The Committee recommends the beneficiation of such ores and its use in the ferro-manganese plants after suitable

agglomeration in the country. This would release lumpy ores for exports. The prospects of exporting agglomerated or nodulised concentrates could also be explored.

(vi) This Committee notes that a committee constituted in 1957 under the earstwhile Ministry of Natural Resources and Scientific Research, had gone into the problem of the beneficiation of low grade manganese ore particularly ores from Karwar, Madhya Pradesh and Rajasthan. The Committee had recommended, *inter alia*, the installation of pilot plants at Nagpur and Jamshedpur for pilot plant studies on low grade manganese ore by the Indian Bureau of Mines and National Metallurgical Laboratory. Based on these studies, the setting up of beneficiation plants was also advocated. This Committee observes that, although a couple of years have lapsed, no progress seems to have been made on the above recommendations.

It is recommended that pilot plant studies on low grade manganese ores for various regions in India should be completed by the Indian Bureau of Mines and the National Metallurgical Laboratory on top priority basis and the designs of beneficiation plants should be worked out by them. The new agency should take care of the matters connected with installation and working of these plants.

(vii) The Committee recommends that concessional royalty rate should be charged for beneficiated ore in order to provide an incentive for adopting beneficiation techniques to upgrade low quality ore. This could be fixed at 50% of the rate of royalty applicable to the grade of unbeneficiated ore.

(viii) The other incentive in the form of special railway freight rate for ore meant for beneficiation is also to be recommended. This is necessary because for one ton of beneficiated ore about 3 tons of low grade ore have to be transported. This may be fixed at 50% of the prevailing freight rate for exports.

(ix) In order to ensure a regular supply of the feed of low grade ore for the beneficiation plants, it will be desirable to attach suitable captive sources of supply to such plants. In case of large efficient units, preference in the matter of grant of leases of additional areas should also be accorded.

4. Transportation and Port Handling

CONCLUSIONS :

(i) The cost of transportation has always been regarded as one of the major factors in the F.O.B. cost which determines the competitive position of Indian minerals in foreign markets. In other manganese ore producing countries of the world such as Russia, Brazil, Gabon, Union of South Africa and Ghana, great advance has been made in the development of transport facility.

(ii) For transporting ore from the mines to the rail-head, use is made of the aerial ropeways on an extensive scale. For example, the mining areas of Chiature (Georgia, Russia) are serviced by an aerial tramway to a 21 mile spur of the main line of the Trans Caucasus railways. In Gabon, a 45 mile cable-way with a capacity of 850,000 tons a year has been built to carry the ore from the mines near Franceville to rail-head at 'M' Binde. In India rope-ways have been used to a very limited extent. M/s. Manganese Ore India Ltd., are operating two rope-ways from their Ukwa mine to Bharweli siding, a distance of 18 miles and from Ramdungri mine to Gumgaon mine, a distance of about a mile. M/s. Sandur Manganese and Iron Ores (P) Ltd., have two rope-ways 8,000 ft. and 10,000 ft. each at their Sandur mines, Mysore. The rest of the producers have to transport ore by road to the rail-head excepting one or two large firms who have railway sidings near the mines. The average ton-mile cost of road transportation is Re. 0·75.

(iii) In almost all manganese producing countries, ore is transported by rail to the ports for export. In Brazil a railway line of more than 200 Km. has been constructed from the Amapa mines to the Porto Macapa. In Gabon, 180 mile rail road has been built from 'M' Binda to a junction point near Dolisie on the Congo Ocean rail road which runs into Atlantic Port of Pointnoire. In Russia Trans-Caucasus Railways carry ores from Chiature area to Betum (125 miles) or Poti (90 miles) on the Black Sea. The ores in Ghana are transported on Sekondi-Kumasi railway line to Tekoradi port, a distance of 39 miles. There have been innovations in the use of rail equipments for the handling and carriage of ores. At Amapa, Brazil the washed ore is drawn from the bottom of 550 tons ore bins into rail-road cars on a single loading track under the bins which is designed with a slight grade permitting an entire ore train to be loaded and assembled by gravity with no locomotive required. A 70 tons car can be loaded in one minute. The ore reaches the port in 70 tons bottom dump cars.

The expenditure on transportation of ore from mine to the port is an insignificant factor of cost in other countries. The rail-haul is comparatively short. In India, excepting in Andhra Pradesh and Goa, ore has to cover an average distance of more than 400 kms. before it is shipped from the port. Similarly the freight cost per ton of ore is in the neighbourhood of Rs. 18·00.

(iv) Steady increase in the size of vessels is bringing about a marked reduction in the ocean freight and shipment of ore. Improved facilities for handling cargo is another factor which has a beneficial effect on the competitive position of minerals in the world market.

In India the port charges generally approximate to Rs. 10·00 per ton as compared to \$ 1·00 a ton at most of the ports of other countries. The loading rate at the Indian ports is in the neighbourhood of 600 tons per day as against the loading rate of 2,000 tons per hour at Porto Macapa, Brazil and 4,000 tons per day at port Elizabeth, South Africa. Production from Gabon is shipped through the Atlantic Ocean port of Point Noire where automatic loading facilities have been

installed. Ghana ores are exported through the port of Tekoradi which has excellent mechanical facilities for handling limited traffic. The slow loading rate at the Indian ports results in abnormally slow turn around of vessels which makes for less favourable freight terms.

RECOMMENDATIONS :

(*a*) *Road Transport :*

(i) In India, mining areas have the poorest roads and this is responsible for high maintenance charges and fuel consumption for transport vehicles. The Committee recommends that intensive road construction or improvement programmes for mining areas should be undertaken. As far as possible new roads should be built to support heavy traffic. Increasingly, the present light trucks would have to give place to heavy diesels. During the study tour of Orissa mining areas the Committee inspected Joda-Dubna Road under construction by the State Government and it was found that this road was not very suitable for heavy ore traffic. The matter has already been brought to the notice of the State Government. It may be desirable for the Central Government to ask the State Governments to particularly bear in mind the needs of heavy load traffic when they implement their road programmes.

(ii) Apart from the construction of new roads, it would be essential to modernise existing roads in mining areas. Attention of the State Governments may be immediately drawn to this aspect. During its tour of Mysore State, the Committee had an opportunity to recommend to the State Government the importance of the repairs of Joida Diggi road and construction of an additional 8 miles road-link to the road on Goa side. The Committee hopes that the State Government would find it possible to accept and implement the suggestions. Similarly there is a strong case for modernising the existing tract between Sarkunda area and newly opened railway station at Barsua in Orissa State for manganese ore traffic in Orissa.

(iii) The Committee is of the view that the Planning Commission should utilise funds at their disposal in consultation with the State Governments and Ministry of Steel and Mines for construction of new roads, as also repairs to and modernisation of the old roads for movement of manganese in various areas.

(iv) The Minerals and Metals Trading Corporation should be provided with certain funds by Government for giving grants to mine owners or for the construction of new roads and modernisation of the existing roads in the mining areas in consultation with the Ministry of Steel and Mines.

(v) Apart from the construction of the main roads in the mining areas as outlined above, attention may also be given to the construction of access roads to an individual mine or group of mines. But the development of such feeder roads upto a distance of 5 miles from the mines should be the responsibility of the individual mine owner or group of mine owners who will be the principal beneficiaries.

(*b*) *Rail Transport* :

(i) The incidence of railway freight has been a subject of great controversy between the representatives of the industries and the railway authorities. The former are of the view that the railway freight has steadily registered a disproportionate increase, but the latter have contended that this is the result of a general rise in basic costs and that the present rates barely meet the operational expenditure.

(ii) The Committee is of the view that frequent changes in freight rates have subjected manganese industry to unforeseen additional strains. As manganese is a sensitive commodity in the world market, these frequent changes must be avoided in future as far as possible. Although, the present concessional rates are considered somewhat excessive and do not satisfy certain sections of the industry, the Committee recommends, as a compromise, that there should be no increase beyond the level of the current rate (as effective from 1-4-63) for another 5 years from now.

(iii) The Committee is of the view that the railways have to keep abreast of the problems of industry while allotting wagons and insisting on the movement of ore in a rake of box wagons, for the reasons already explained in this chapter.

It would be essential that the wagons are supplied at each separate loading point as per the indent of the producer or *prorata* thereof to enable him to take his ore at the port in a definite proportion for blending etc.

The insistence of the railways on the use of rake of box wagons has created another problem. At the port, the stacking space frontage for a particular party being limited, it is not possible to take rakes for unloading. This results in serious delays in the supply of right type of ore. The Committee recommends that, depending on the merit of the case four wheelers may be allowed for manganese ore movements.

(iv) It is further recommended that separate sidings should be provided for manganese ore at all the important loading points and weighment facilities given wherever possible.

(*c*) *Rope-ways* :

As Rope-ways are relatively economical modes of transport, suitable surveys should be carried out in selected mining areas for installation of ropeways systems.

(*d*) *Ocean Transport* :

(i) It is the considered view of the Committee that facilities at the ports should be improved so that a ship can be loaded in two days. The Committee feels that the port authorities are in a better position to plan necessary improvements. Plans for modernisation of loading facilities and berthing of large carriers are already under discussion in relation to

particular commodities such as iron ore. The Committee recommends that the needs of manganese ore should also be kept in view when such plans are drawn up and implemented.

(ii) At present manganese ore is generally exported in liners of about 10,000 tons capacity as against charters of 30,000 tons capacity in other countries. The rates of liners are generally much higher as compared to charters. There would be appreciable reduction in c.i.f. cost if manganese ore is exported in charters of 20,000 tons capacity. Interest of manganese trade has suffered partly due to a multiplicity of exporters selling small packages in different markets. Now that Government have taken a decision to canalise all trade of manganese through two public sector agencies *i.e.* Minerals and Metals Trading Corporation and **Manganese Ore** (India) Limited, it should be possible to secure better prices for Indian manganese ore through a co-ordinated operation in the traditional and new markets. It should also be possible to achieve economies of large charters.

There is no room for any increase in port charges.

Port-wise recommendations

(*i*) *Visakhapatnam.*—(a) An important point which came to the notice of the Committee during its tour was the difficulties experienced by the exporters due to the insistence of the railway to transport ore in rake of box wagons. The Committee recommends that, on account of the peculiarities of this trade arising out of the numerous grades and a need for their blending, the railways should not insist on rakes and they should allow the movement of ores on four wheelers.

(b) There is uniform skip rate of Rs. 2.00 per skip both for high grade and low grade ores at the port. The Committee recommends that there should be another slab for low grade ores.

(*ii*) *Madras Port.*—(a) The Committee recommends that berth South Quay may be used for manganese ore shipment. Stacking space of 10,000 tonnes is available at the key of the basin but the vessles may be mainly fed from the present manganese depot which is about a mile away. In the event of contingencies stacks at the key should be used. Thus the loading time will be minimised as also the loading rate will increase. The Committee further recommends that ore may be brought from Manganese depot on trollies with flat tubs.

(b) The port officials informed the Committee that as soon as iron ore programme is completed, Scoda cranes would be available. Shift derricks would also be available and work can be started as soon as basin is ready. The Committee recommends the implementation of these programmes.

(c) The Committee is confident that a loading rate of 3,000 tonnes per day can be achieved at Madras Port if the above suggestions are implemented. Although the present traffic of manganese ore at the port is limited, more of it will be attracted once higher loading rate and better facilities are achieved.

(d) The port charges at Madras are high because of high labour cost. The Committee feels that this can be cut down if idle labour hours are avoided.

(*iii*) *Calcutta Port.*—(a) The Committee recommends that there should be complete co-ordination between the port officials and the shippers in order to attain efficiency at the port. The sailing dates, the quantity to be loaded and the type of ships requisitioned should be made available to the port officials well in advance.

(b) The railway should provide 4 wheelers instead of box wagons.

(c) The stacking depot for manganese ore is in close proximity to other minerals such as iron ore and the chances of contamination are serious. Manganese ore should be so stacked as to avoid any contamination.

(*iv*) *Bombay Port.*—(a) The movement of vessels from one berth to the other for loading results in abnormal delays at the port. It is suggested that dredging may be done in some cases. The movement of vessels consumes considerable time and the shippers have to undergo lot of difficulties. Quick loading and un-loading is an important element which has to be considered. The Committee recommends that the port authorities may take into consideration the above points while planning modernisation programmes.

(b) The Committee recommends that the existing wagons of the trust railway, most of which are in an advanced stage of dilapidation, may be immediately replaced by 100 K.L. type wagons to be procured from railways.

(c) The weigh-bridge provided by the Trust is inaccurate giving shortages amounting to 5%. The Committee recommends that either two weigh-bridges should be maintained or alternatively, an automatic recorder should be provided at the existing weigh-bridge, or a weigh bridge with punch card system may be installed.

(d) It may be possible to use grab fitted mobile cranes for loading and unloading wagons.

(*v*) *Marmugao Port.*—The Committee is of the view that Marmugao port can handle larger quantities of manganese by wagons and barges combined. Low grade ores of North Kanara, Mysore and also Sandur ores may be exported through this port. Necessary facilities may be provided for this.

5. Mining, Mine Management and Mine Financing

CONCLUSIONS :

(i) Manganese Mining Operations in various parts of the world cover a wide range of modes of production, from manual quarrying dating back to about a century to modern sophisticated methods and techniques. The major portion of world's manganese ore production is, however, derived from open pit or shallow underground workings.

Open pit mining is the pattern which obtains in case of the majority of mines in India, South Africa, Brazil and Congo. Underground mining is generally the rule in USSR, USA, Chile, Morrocco, Cuba and is also a prominent feature of a few important deposits in India.

The Russian mines have been developed to an annual production capacity of ten million tons. Brazilian and Gabonese mines are at present geared for a million ton each per annum.

(ii) In India, small mines are a pre-dominent feature of the manganese industry. In the year 1962, 475 mines accounted for a total production of 1.2 million tons out of which small-scale units producing less than 10,000 tons per year were responsible for 48% of the production. There were only two mines with annual production range of 60,000 tons.

(iii) In a highly competitive market as manganese, only sizeable units which can adopt modern techniques of mining and realise economies of scale can afford to remain in production in the long run.

(iv) With the exception of a few companies, majority of mine-owners have slender financial resources, which, at times, are supplemented by financial assistance from promoters. The total capital investment in manganese industry would be of the order of Rs. 5 crores only. As against this the investment in the development of Brazilian deposits amounted to $ 50 million in 1958 for a production of about 600,000 tons of manganese ore, and in Gabon in 1961 a capital outlay of $ 12 million was in relation to a production of 500,000 tons (expandable to one million ton) per annum.

RECOMMENDATIONS :

(i) In order that Indian manganese industry may face the present competitive conditions of world market, it is necessary for mining units to adopt scientific techniques of mining and operate on an economic scale of production.

As all mine-owners are not in a position to acquire, service and maintain costly mining machinery such as buldozers, compressors, transport vehicles, pneumatic rock drills etc., it should be possible to constitute a pool of such essential equipments at a central point from where it could be made available to mine-owners on suitable terms. This could be handled by either a co-operative of manganese miners or a Government department like the Indian Bureau of Mines or a public undertaking like the M.M.T.C., who are at present, the largest single organisation for buying and marketing of manganese ore.

(ii) The present concession of entitlement for import of mining machinery against 10% of foreign exchange earnings, should be extended upto 25% of the value of exports.

(iii) Co-operative departments of the State Governments or central agencies responsible for production or procurement or marketing should provide necessary leadership for organising wherever possible, small

mining units into co-operative societies for one or several purposes *e.g.*, provision of capital finance, purchase of equipment, operational know-how, marketing and sales.

(iv) To encourage mechanisation and adoption of modern scientific techniques, Government might consider a suitable scheme of fiscal and tax incentives (please see details in Chapter on Taxation and Fiscal Levies).

(v) For major ore deposits containing reserves of 2 to 2.5 million tonnes or higher the economic scale of production of a mechanised mine would be of the order of 50,000 tonnes per annum. In case of smaller deposits containing reserves of the order of 1 to 2 million tons an annual production of 30,000 tonnes could be planned on partially mechanised or un-mechanised basis.

(vi) To meet the requirements of capital investment on equipment and machinery, the existing agencies like Industrial Credit and Investment Corporation, National Investment Development Corporation and Industrial Finance Corporation should be specially oriented to look after the needs of manganese industry. Taking into consideration the conditions of the mining industry in the country in general, the Committee feels that there might be a case for the creation of a Mining Finance Corporation in the Fourth Plan which would particularly cater to the needs of mining industry in all important basic minerals.

6. Mining Legislation and Fiscal Levies

CONCLUSIONS :

(*i*) Considering the risks and hazards inherent in mining ventures, it is important that suitable incentives should be built in mining and fiscal laws to attract enterprising prospectors and to induce entrepreneurs to deploy their managerial skills and capital resources in the field.

(*ii*) Besides direct governmental levies such as royalty, income-tax sales tax etc., stringent legislation on mineral disposition, safety and labour amenities are adversely affecting the exports of manganese.

(*iii*) *Income Tax.*—(a) In most of the advanced countries a new mine is given the opportunity to recover, before the imposition of taxes, a large part of the capital expenditure. A three year tax-exempt period for new mines, income tax allowances for pre-production costs, generous depletion and depreciation allowances are some of the concessions given to the mining industry in Canada. Similar reliefs are also available in Australia, U.S.A., U.K. etc.

(b) In India the Income Tax Act, 1961 and the Income Tax Rules, 1962, provide only for depreciation allowance and development rebate which are much low as compared to other countries. A few other concessions prevalent in the above countries are non-existent in India.

(c) The freight earning of a shipper is taxable under the Indian laws which inflates the actual ocean freight charges from Indian ports to the consuming markets.

(*iv*) *Sales Tax.*—There are two types of sales tax *viz.* Central Sales Tax levied under the Central Sales Tax Act on sales in the course of inter-state sales and the other local sales tax levied under the Sales Tax Acts of various State Governments on intra State sales. When a mine-owner exports a commodity directly, the sale is not liable to tax, but where he sells it to another dealer who in turn exports it, the first sale attracts the provision of the sales tax, but the second does not. Method of taxation is complex and it varies from State to State.

(*v*) *Canal Toll Dues.*—Vessels carrying mineral ores have to pay to the Suez Canal Authorities canal toll dues which has the effect of inflating the actual ocean freight.

(*vi*) *Local Taxes.*—Some of the mining areas have been brought under the purview of municipal taxation and gram-panchayat rules and the mine-owners have to pay municipal and panchayat taxes which are contributing to the high cost of production of manganese ore.

(*vii*) *Royalty.*—International prices for manganese ore are still low. As the out-look for future is uncertain, the present rates of royalty do not appear to be justified and have brought about additional burden on the industry.

(*viii*) *Disposition of mineral rights.*—(a) Large areas of manganese ore have been reserved in various states for exploitation in the public sector. Even though the State Governments have no plans to work the areas, the same are not being released to the private parties.

(b) Some of the State Governments are granting renewal of leases for a period of 10 years only although under the Mines and Minerals (Regulation and Development) Act, 1957, maximum period of 20 years is provided. This will inhibit investment, planning and production.

(*ix*) *Safety in mines and labour welfare.*—The need to provide for safety and welfare of workers in mines can hardly be ignored. At the same time it has to be ensured that such measures do not put undue strain on the mine-owners and obstruct their normal working. Some of the provisions in the Mines Act and Mines Rules could be oriented to suit the needs and working conditions at the manganese mines.

RECOMMENDATIONS :

(i) *Income Tax.*—The following reliefs are recommended with regard to the levy of income tax on manganese mines:—

(a) Expenses incurred on prospecting and exploration of manganese mines to be treated as revenue expenditure.

(b) Tax holiday for 3 years for new mines.

(c) Increase of the permissible depreciation allowance to 30% for mining machinery and equipment.

(d) Expenses incurred on research and pilot plants in beneficiation or upgrading of ore to be treated as revenue expenditure.

(*ii*) *Sales Tax.*—The Committee recommends that the state Governments should be requested to exempt sales tax, central as well as local on manganese ore intended for export. Alternatively, they should be requested to adopt the West Bengal system of taxation in the case of manganese ore.

(*iii*) *Canal Toll Dues.*—Efforts should be made to secure some relief from the above dues for manganese ore.

(*iv*) *Local Taxes.*—The Committee recommends that the mining townships where suitable amenities, such as, facilities for hospitals, creches and canteens, conservancy, sanitation and other services are already provided by the mine-owners, should be exempted from gram-panchayat or municipal taxation. However, the areas where adequate facilities are not provided by the mine-owners and the said services are provided by the local bodies, the levies may be imposed at the minimum rates provided under the Rules.

(*v*) *Royalty and Dead-rent.*—The Committee recommends the following rates of royalty on manganese ore:—

Dioxide ore (MnO_2 78% and above Fe 4% Maximum)	Rs. 10·00 per tonne
45% Mn. and above	Rs. 4·00 per tonne
35—45% Mn.	Rs. 2·00 per tonne
Below 35% Mn.	Re. 1·00 per tonne

It is further recommended that the dead-rent on manganese ore for the last 3 years should be waived in view of depressed market conditions.

Further, the Committee considers that the State Governments should be advised to collect arrears of dead-rent in instalments equal to the amount of royalty chargeable per tonne of ore on resumption of production. This will act as an inducement to the mine-owners to start mining operations.

With regard to the question of levy of royalty at the pit-head value of minerals, the Committee recommends that wherever departmental rules or instructions are not in accordance with the principle enunciated by Mysore High Court, immediate steps should be taken by concerned State Governments to modify or amend such rules and instructions wherever these are due.

(*vi*) *The Manganese Mines Labour Welfare Fund.*—The legislation may not be enforced till manganese ore industry is fully rehabilitated and attains prosperity.

(*vii*) *Disposition of Mineral Rights.*—(a) The Committee recommends that manganese bearing areas reserved for State exploitation should be released for exploitation in private sector if the State Governments do not have any definite plan of the development and working of the areas within a reasonable period from the date of reservation. Special consideration should also be given to granting leases of suitable areas to the ferro-manganese industry so that wherever possible it can depend upon its own captive mines for a uniform and regular supply of ore.

(b) The Committee is of the view that the renewal of mining lease should not be granted for less than the maximum period provided under the Mines and Minerals (Regulation and Development) Act, 1957, unless a lessee himself applies for a shorter period. The renewal of the lease for a shorter period will inhibit investment, planning and production.

(c) The Committee further recommends that applications for mining leases in the reserved area should also be considered for minerals other than the one for which it has been reserved provided that the working of the additional minerals in the areas applied for will not affect the development of the remaining part of the reserved area.

(*viii*) *Power of Revision of Central Government.*—(a) The Committee recommends that the power of the Central Government in the matter of regulation and control of mining rights having been clearly defined in the Constitution, the State Governments should take steps to give immediate effect to the orders passed by the Central Government on applications made to them under the provisions of Mineral Concession Rules, 1960.

(b) A reasonable time limit for the disposal of revision applications should be provided in the Mineral Concession Rules, 1960, so that redress to aggrieved parties is not unduly delayed or denied when it is most needed.

(*ix*) *Labour and Safety.*—The requirements laid down under rule 33 of the Mines Rules regarding laterines and urinals in mines should not apply to manganese mines. Similarly rules 64 to 71 regarding provision of canteens in mines may be relaxed.

7. Marketing

CONCLUSIONS :

(i) The annual world market of manganese ore is likely to increase to 10 million tons by 1975 against the present level of 5 million tons. Captive sources of supply developed by the principal consumers of manganese ore can be expected to meet 50% of this demand leaving a "free demand" of about 5 million tons per annum available to mine-owners and suppliers of manganese not committed to particular users.

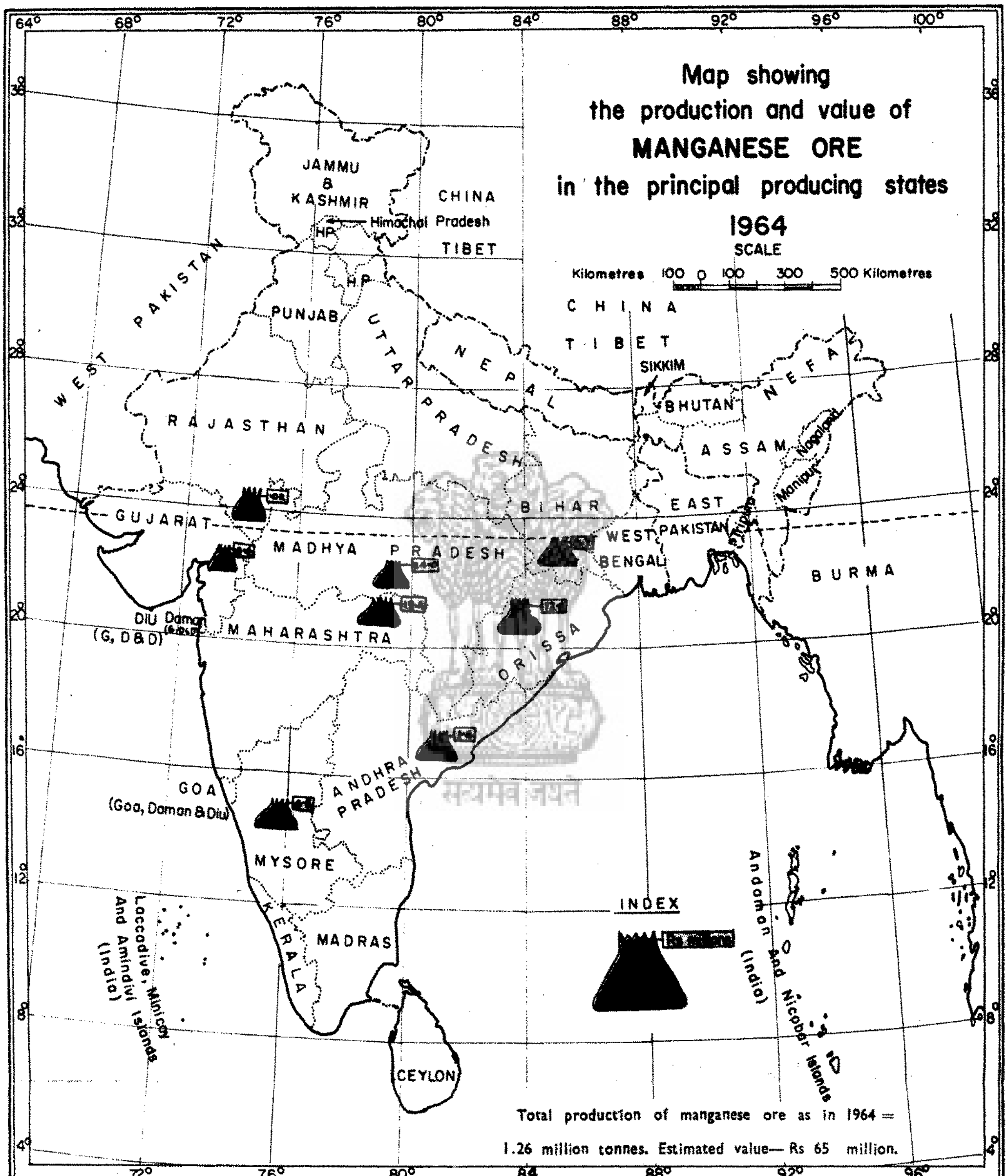
(ii) The figure of 5 million tons of "free demand" is considered substantial especially when compared to the present volume of trade *viz.* 2 million tons per annum. As India is one of the largest producers

of manganese ore among "non-captive" sources, it can reasonably hope for a larger share in total world exports provided the present production is expanded to produce the requisite quantities with due regard to the prime need for reducing costs. The increased world demand, however, need not necessarily imply any significant rise in international prices as the major portion of production will be derived from those sources where costs of production are low and better port facilities are available.

(iii) Under the existing pattern of trade, the demands of ore are pooled and met by a few intermediate ore purchasing agencies collectively for all consumers. This places the buyer of ore in a relatively advantageous position with reference to sellers, because while inter-se competition among the former is practically eliminated the suppliers continue to operate on an individual basis. In India, apart from the disparity between the uneconomic costs of production and the international prices, the multiplicity of small exporters and other similar factors continue to operate against the prospects of Indian exports.

RECOMMENDATIONS :

The Committee feels that with a view to maximising exports, it is desirable to canalise the exports of manganese through one or two central agencies which by means of carefully co-ordinated operations can obtain the best prices and terms for Indian manganese ore. The Committee notes that the Government of India have taken a decision to canalise exports of manganese ore through (i) Minerals & Metals Trading Corporation of India Ltd., (ii) Manganese Ore (India) Ltd. which are both public sector undertakings. The working of the new arrangements should be carefully reviewed from time to time from the point of view of significant gains in India's export trade and foreign exchange earnings. The Committee also recommends that M.M.T.C. being the only agency for purchasing ore raised by small mine-owners, it should take on itself an active role in providing technical and wherever possible managerial and financial assistance in developing and modernising their mines, with a view to maintaining quality or grade and reducing costs of production.


Map showing
the production and value of
MANGANESE ORE
in the principal producing states
1964
SCALE
Kilometres 100 0 100 300 500 Kilometres
JAMMU & KASHMIR
CHINA
Himachal Pradesh
HP
TIBET
WEST PAKISTAN
PUNJAB
UTTAR PRADESH
NEPAL
CHINA
TIBET
SIKKIM
BHUTAN
NEFA
ASSAM
Nagaland
Manipur
RAJASTHAN
GUJARAT
MADHYA PRADESH
BIHAR
EAST PAKISTAN
Tripura
WEST BENGAL
BURMA
DIU Daman
(G, D&D)
MAHARASHTRA
ORISSA
GOA
(Goa, Daman & Diu)
ANDHRA PRADESH
MYSORE
KERALA
MADRAS
Laccadive, Minicoy And Amindivi Islands (India)
INDEX
Andaman And Nicobar Islands (India)
CEYLON
Total production of manganese ore as in 1964 = 1.26 million tonnes. Estimated value— Rs 65 million.